THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Organizational Innovations In Shipyard Safety

U.S. DEPARTMENT OF TRANSPORTATION
Maritime Administration and
U.S. NAVY
in cooperation with
Bethlehem Steel Corporation
Marine Construction Division

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FOREWORD

Safety has long been a topic of concern to U.S. ship builders. Accidents which involve disabling injuries or death cost our nation billions of dollars each year. Reduced productivity, increased medical expenses and skyrocketing insurance costs are major contributing factors. But the less obvious elements, time lost filling out accident reports and administering first aid, must also be considered. This, along with the money value of time lost by workers other than those with disabling injuries has been as high as $15,100,000,000 in a recent one year period.

According to the U.S. Public Health Service figures available at the beginning of this project, compensation paid to all workers in the nation who were under workers' compensation laws was approximately $32,500,000,000. This figure includes wages, insurance and medical costs, as well as the indirect costs mentioned above. 40,000,000 days were lost by workers injured on the job, of the 2,100,000 injuries, 610,000 were to the trunk followed by 320,000 to fingers and 270,000 to legs.

Given the type of working conditions and sizes of material and equipment, it is not surprising to find that the rate for total lost work days in the ship and boat building trades was over 2.43 times the average for all principle industries.

The purpose of this report is to evaluate the effectiveness of reducing injuries through the use of small work teams in the identification and solution of safety related problems in a shipyard environment.

ACKNOWLEDGEMENTS

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The author of this report is E. J. Byrnes, a former Facilitator in Peterson Builders participative management program and is based on ideas and efforts of the newly formed Safety Action Team known as the Life Savers.

The National Shipbuilding Research Program is a cooperative effort of the Maritime Administration Office of Advanced Ship Development and Technology, the U.S. Navy and the United States shipbuilding industry. This research project was administered by Panel SP-5, Human Resource Innovation, of the Ship Production Committee of the Society of Naval Architects and Marine Engineers (SNAME). Frank Long, principal consultant of the consulting firm Win/Win Strategies is the Chairman and Program Manager of Panel SP-5.

The object of this research was to determine if the exemplary safety records that Japanese shipyards have attained through the use of “small groupism” (shoshudansugi) can be translated into effective organizational innovations to improve productivity through the promotion of a safer working environment in U.S. shipyards.

TABLE OF CONTENTS

SECTION I

EXECUTIVE SUMMARY

Peterson Builders Inc. (PBI) has long recognized that participation in decision making on all levels enhances morale and assures quality performance. It is top management's belief that our employees are our most valuable asset. In keeping with this long standing tradition PBI has sponsored employee involvement in the form of Quality Circles since 1981. It is clear to us that those individuals who are closest to a job are the ones who, in effect, are the experts. The same can be said about safety. Those who encounter potentially hazardous situations in the work place on a day to day basis often have the best solutions due to the fact that it is their own welfare, as well as that of their fellow-employees, which they are concerned with.

Early in 1980 Ellsworth L. Peterson, PBI's President, noticed an article on participative management in a trade magazine. Being cognizant of the necessity for a team effort in making a company successful, he investigated the concept further during a trip to Japan and was favorably impressed. Upon his return to the States he tasked his Vice President of Production to gather further information. By mid 1980 members of upper management had attended a Q.C. briefing in Milwaukee. After their return, J.F. Beardsley & Associates International Inc. was contracted to provide an in-house introductory seminar for all managers, department heads, foremen and leadmen. The same consultant conducted the initial training for employees and by December of 1980 a steering committee representing a complete cross section of the yard was established. Between May and September of 1981 ten Circles were formed. Since then participation has varied reflecting fluctuations in employment. At its peak, 18 Circles were active representing nearly 25% of our work force.

Since the establishment of a participative management system, PBI has enjoyed a return on investment that has averaged 3.5 to 1. In light of these positive results, it is easy to see why the idea of establishing a Safety Action Team using Q.C. training and techniques was met with enthusiasm.

The Safety Action Team has more than proven their contribution to the improvement of the safe work place atmosphere at PBI. Lost time accidents and lost time days have been reduced by 54% and 44% respectively over the past year. Over all, the reportable accident rate has decreased by 20% during the same period.

These results show that the Safety Action Team concept is a worthwhile program for any shipyard regardless of size or location. Eliminating just one lost time accident more than justifies the cost of the program. Return on investment is almost immediate in both cost and productivity.

The Safety Action Team has become another very valuable asset to PBI everyday operations. Management has requested the Team to continue functioning as a permanent member of the Safety and Quality Circle program.

SECTION II

INTRODUCTION/OVERVIEW

Although 1933 was just another depression year for many people, it marked the beginning of Peterson Builders. The company has come a long way since the construction of its first wooden fish tug. PBI used the skills and ingenuity of its founder Fred J. Peterson to capably meet the demands of its customers, whatever the size or type of vessel needed. Right from the beginning, the company established a proven record for being able to build a quality vessel, on time at a profit, and that reputation is very evident today nearly 54 years later.

PBI is a small non-union marine construction facility employing nearly 1,000 people during peak production. PBI has encouraged and trained employees to be multi-skilled by allowing transfers from trade to trade as the workload demands. This diversely skilled work force enables the company to be unique in its ability to construct ships and support products of wood, steel, aluminum and glass reinforced plastic.

Peterson's main yard covers 13 acres and has 2,000 feet of water frontage. It maintains a floating drydock with 1,100 long ton certification, 11 berthing spaces and several 200 ton cranes. Over $6^1/_2$ acres are under roof to assure uninterrupted year round construction. Other facilities include climate controlled paint and blast buildings and a thermal spray (metallizing) area.

The computers impact on the shipbuilding industry is evident throughout the yard and reflects the company's commitment to employ the latest available technology in the design and construction of vessels. Our Computer Aided Design (CAD) System was one of the first in the United States to be used for the creation of ship construction drawings. Numerically controlled plasma and flame cutting machines, Conrac pipe benders, and Shoda routers, are just a few examples of the innovations that improve accuracy and repeatability, however, the skilled craftsman remains the most important element to quality and profitability.

PBI has just successfully completed a contract for four 225' steel United States Navy Rescue/Salvage vessels. They are rugged, fast and durable. Each ship will support a complement of 87 Navy personnel with habitability spaces and medical and storeroom areas all designed to satisfy new updated standard requirements. Their duties will be as diversified as blasting coral reefs to widen harbors, patrol duties, support and supply services to the fleet, space craft recovery, as well as the traditional duties of salvage operations, rescue and retrieval missions, fire fighting and extensive diving operations.

Currently under construction are five ships of the new Mine Counter Measure (MCM) "Avenger" class. As part of the Navy's mine warfare renewal program, the MCM'S replace ships in service since the early 1950's. PBI has been a leader in mine craft construction since that time, longer than any other shipyard in the world. This new generation of wooden ships in Peterson Builders' continuing shipbuilding expertise, brings the total of specialized mine craft built at the yard to 50.

This new "Avenger" class MCM represents the largest wooden ships in the Navy fleet. They are 224' long with a 39' beam and accommodate a crew of 81 Navy personnel.

Beyond design and construction capabilities, PBI is also extremely proud to be the only Small Business shipyard whose entire procurement system has successfully fulfilled the Contractor Procurement Systems Review (CPSR) performed by the Naval Sea Systems Command. Integrated Logistics Support (ILS) capability added to an ever increasing list of support services such as central procurement and crew training truly makes PBI a "Full Service" shipbuilder.

Currently the economic outlook for U.S. ship builders can only be considered bleak. The work demand for new vessels has plunged dramatically from the dizzy heights of the seventies. Little if any commercial work is available and many yards, not capable of meeting the required construction standards of the United States Navy, have fallen by the wayside. Needless to say, all of the skilled personnel, hardware, software, facilities, improved and expanded programs and departments can't finction unless we are building ships. It is to this end that PBI continues to aggressively market a variety of patrol boats and mine counter measure vessels to fit the requirements of foreign allies deserving improved coastal surveillance and defense capabilities.

SECTION III

POLICY GUIDELINES

The basis for developing a Safety Action Team was to draw upon PBI's current employee involvement program's organizational structure and problem solving techniques. General policy guidelines developed for this project included:

- Build an attitude of Safety Awareness and Safety Prevention among all employees.
- Inspire more effective teamwork.
- Promote personal and leadership development.
- Membership based solely on voluntary participation.
- Encourage participation by individuals who have not yet had the opportunity to become involved in the present Quality Circle Program.
- Encourage a balance of production workers, first line supervisors, and department heads.
- Adhere to established policy of limiting employees to membership in only one Circle at a time.
- Operate under the established policy guidelines of the existing participative management program with regard to conducting meetings, leader selection and training in problem solving techniques.

SECTION IV

CANDIDATE SELECTION

The tenet of "Success Through Voluntary Participation" was upheld by publishing an article in the company newsletter, known as "Shop Talk", soliciting individuals interested in joining a group whose sole function would be the identification and solution of safety related problems throughout the yard. The response was very good, especially among those employees who were already involved as Quality Circle members. It was this enthusiasm among Circle participants that caused the first stumbling block in the project.

According to the guidelines mentioned above those active Q.C. members who wished to become part of a Safety Action Team (SAT) had to choose between becoming part of a new group or staying with their original unit. Some suggested that their entire Circle become the SAT but when this was discussed during their regular weekly meetings, none of the Circles wanted to limit their activities to safety related problems only.

After interviewing the remaining candidates, seven individuals representing a cross section of the yard were selected to form the team.

NAME	TITLE	**TERM** OF EMPLOYMENT
Dan Kressig	Chief Industrial Engineer	7 yrs
Niles Weborg	Dept. Head, Hull Erection (wood)	26 yrs
Larry Iverson	Dept. Head, Warehousing	22 yrs
Rich Propsom	Leadman Shipwrights/fdn install.	14 yrs
Tom Srenaski	Paint Dept. Planner	7 yrs
Dave Nieman	Safety Hygienist	7 yrs
Bruce Atkins	Safety Supervisor	15 yrs
Dave Getman	Facilitator	7 yrs

These individuals were chosen for a number of reasons. First of all, they expressed the most intense interest of the eligible applications received. Second, they represented a broad cross section of the yard. Three from production, the largest group of employees, two from the Safety Department because they normally are the first to be notified of any problems, one from the Industrial Engineering Department to provide a background in statistics and experience in communications with all departments, and one from Warehousing, a department whose functioning, although vital, is often overlooked. The Facilitator provided training, guidance and acted as liaison between the Safety Action Team and the existing Quality Circle groups. Third, by using employees with no less than seven and up to 26 years of experience, we had a group who, at one time or another, had worked in most of the production areas in the yard.

The only drawback to this group was that it was top heavy in supervisory representation because the production workers who had expressed interest chose to remain with their original groups. Thus we did not attain our goal of having a balance of production workers, first line supervisors, and department heads.

SECTION V

TRAINING

The Teams first formal meeting was one of a general orientation nature. Dave Getman, the group's Facilitator, showed a video tape entitled' 'Meeting in Progress" produced by Roundtable Productions Inc. The film was designed as an aid in developing sensitivity to the needs of others and skills in conducting effective meetings to make the most productive use of the time available. The tape used role models to simulate typical situations which often arise in group relations. The membeuurs also learned the importance of reaching consensus during both the problem selection and the problem solution process.

To follow the standard training procedure used for Quality Circles, the Team was introduced to the technique of brainstorming near the end of their first session. This intentionally uninhibited method of generating large quantities of ideas also allows people to become comfortable in speaking up and expressing themselves in a non-threatening environment. As an exercise in this technique, the Safety Action Team began to generate a long list of possible names for their group. By the end of their next session they had chosen (by consensus) to call themselves the' 'Lifesavers". A fitting name for a group whose sole reason for existence was to promote a safe work place for themselves and their fellow employees. At this session the Lifesavers also chose the representative from the Industrial Engineering Department to function as the group's leader.

In the following weeks the SAT became conversant in the rest of the more commonly used aids to effective problem solving.

Cause and Effect Analysis. (Sometimes known as fishbone diagrams.) This is the process of describing what goes into making something of quality or discovering the root cause of a problem. It provides people with a structure for focusing their creative energies on a common goal.

Checksheets. These are simple tools for the collection of various kinds of data (counted data, location data, etc.). Since accurate data are vital to effective problem investigation, they are used throughout the problem solving process.

Graphs. The visual presentation of data. Complex collections of data can be easily understood and relationships between sets of data demonstrated with the aid of a few well-drawn graphs.

Histograms. These special types of column graphs show how variable measurements of a given object or process are. They also help visualize changes and problems in processes.

Pareto Diagrams. Another specialized type of column graph. They are used to prioritize problems so that the most effect for the least amount of effort can be realized and to distinguish between major and minor causes.

Management Presentations. These are the formal vehicles by which problems are highlighted and proposed solutions are presented to management for approval and implementation.

The next portion of the Lifesavers training agenda was Control Data Corporation's PLATO computer-based training. SMIP (Statistical Methods in Problem Solving) is a combination of text readings and/or activity lessons completed on an IBM-PC compatible computer. The advantages of this method over formal classroom education are that participants can advance at their own pace and can complete the lessons during hours that most conveniently fit their day to day schedule.

The areas that the SMIP training addressed were: data collection (sample collections, checksheets, etc.), charting (graphs, scatter diagrams, etc.), frequency distributions (Histograms), control charts (x-r charts, Np and p charts, c and u charts, etc.) and the application of all of the above in monitoring ongoing processes.

Hazard identification and accident investigation were two additional topics that are not usually considered typical participative management training subjects but were considered very appropriate for this unique group. Bill Koepnick, a representative of the Wisconsin Council of Safety, conducted three instructional sessions. The first dealt with knowing how to interpret and use material safety data sheets; the second explained how to recognize potentially hazardous situations before they result in serious injury; and the last showed what to do at the scene of an accident and the steps necessary to preserve evidence, gather information from witnesses and write concise accident reports.

SECTION VI

PROBLEM IDENTIFICATION

The guidelines that the Safety Action Team used in determining what steps would be followed in the problem solving process were based on information provided by Rieker Management Systems of Los Gatos, California.

Step one: Identification of problems and the selection of one to work on. Some of the techniques recommended in this phase are: brainstorming, checksheets and pareto diagrams.

Step two: Definition of the problem selected. Techniques that are useful in this phase are: cause and effect diagrams, checksheets and pareto diagrams.

Step three: Investigation to collect data and facts. Checksheets, graphs and histograms are suggested for this step.

Step four: Problem analysis to determine all possible causes and select the major ones. Recommended techniques are: brainstorming, cause and effect analysis, checksheets and graphs.

Step five: Solution. This includes choosing the solution that has the greatest benefit for everyone, getting management support, and implementation. The same techniques as in Step four can be used here as well as formal management presentations.

Step six: Confirmation of results. The continued collection of data and maintenance of records assure that the implemented solution has its desired effect. Check sheets and graphs such as histograms and control charts are useful in monitoring results.

SECTION VII

ACTION TEAM UNDERTAKINGS

The Lifesavers brainstormed a list of 79 safety or safety related problems over the course of two meetings following the completion of their training. The Quality Circles were asked to devote one of their meetings to similar brainstorming sessions. Their lists, after eliminating duplications, resulted in 31 additional items for consideration. Because of the large number of problems identified the Team decided to break the list into two categories: easily solvable (88 items) and complex problems (22 items). The easily solvable problems being ones assigned to Team members to act upon individually. Some examples of these were: tag lines not being used on loads, improperly secured gas cylinders, insufficient eye wash stations, and split scaffolding planks. The complex problems were those that would require a higher authority to fulfill.

The 22 complex problems were ranked on Productivity Development Systems, Inc. Priority Assessment Worksheets (see Fig. 1) and a point value assigned to reflect degree of importance, resources needed, authority, complexity, and time to implement. After each Team member filled out the sheets individually, the sum of their ratings were totalled. The items with the highest numerical score were determined to be the most likely to be accomplished successfully. The problems they quantified were:

1. Electrical in Building #70.
2. Congested deck areas.
3. Eye injuries.
4. No way to get material to balcony in Building 70 when bridge crane is tied up.
5. Constant violation of hard hat, safety glasses and side shield rules-supervisors.
6. Unauthorized personnel changing scaffolding.
7. Poor vehicle preventive maintenance.
8. Poor ship and building ventilation.
9. Potential hazard when opening/closing big doors.
10. Lack of safety awareness/concern among supervisors.

PR OR TY ASSESSMENT WORKSHEET

PROBLEMS OR OPPORTUNITIES	IMPORTANCE	RESOURCES NEEDED	AUTHORITY	COMPLEXITY	TIME TO IMPLEMENT	RESULTS	OTHER	TOTAL
	5—Important, Pressure, 4— 3—Some Concern 2— 1—Little Concern	5—Modest 4— 3—Considerable 2— 1—Large Amount	5—Circle Leader 4— 3—Two Levels 2— 1—Several Levels	5—Not Complex 4— 3—Modest Complexity 2— 1—Complex	5—Month or Less 4— 3—Three Months 2— 1—Six Months or More	5—Measurable 4— 3—Some Indicators 2— 1—Intangible	5— 4— 3— 2— 1—	SUM THE RATINGS

Figure 1

11. Qualifying crane operators (overhead).
12. Equipment overloading.
13. Material storage in pickling area of pipe shop (chemicals).
14. L.P. tank-improper mounting.
15. Crawler cranes pack snow (slippery conditions).
16. Electrical breaker boards.
17. Oil on black top (cranes).
18. Ice hazard (accumulation on roofs).
19. Unclear responsibility for snow/ice (in front of doors).
20. No program for off-job safety.
21. Scheduled hard hat maintenance.
22. No access to material on Building 21 balcony if bridge crane is occupied.

The Lifesavers discussed each of the problems in terms of costliness and solvability. They decided that given the nature of their purpose for forming, they should zero in on the problems ranking high in importance regardless of the resources needed, complexity or time to implement ratings. The subjects scoring the highest in this category were:

#5. Hard hats/safety glasses/side shields-supervisors. (This reflected the concern of the group that regular infractions of accepted company policy with regard to the use of these personal safety devices were not being taken seriously enough by some supervisory personnel.)

POINT TOTAL: 35

#10. Lack of safety awareness/concern among supervisors (much the same as #5 except that this referred to work areas and equipment).

POINT TOTAL: 34

#3. Eye injuries (refers to the number of instances that injuries occur).

POINT TOTAL: 34

#13. Material storage in pickling area of Pipe Shop—chemicals (this echoes a concern for the proper storage and issuance of solvents yard wide).

POINT TOTAL: 34

#2. Congested deck areas (the hazards and problems caused by hoses, air lines, cables and cords running haphazardly across decks and through hatches and passageways).

POINT TOTAL: 33

#9. Potential hazard when opening/closing big doors (the large hinge type door systems on the ship construction buildings require 3-5 men to push open or closed and can be caught by gusts of wind and swing violently one way or another without warning).

POINT TOTAL: 29

Because of the close interrelationship between the three problems that the group perceived to be the most important, the Lifesavers decided to consider them aspects of one larger problem. Their goal for their first project — reduce accidents through the enforcement of company rules and guidelines regarding use of personal protective equipment.

A. SAFETY ACTION TEAM PROJECT ONE: After the Lifesavers had determined what project to focus their attention on they discussed several ways in which information could be collected. They decided to begin by gathering historical data on compensable work related injuries from company records. As you can see from the accompanying Chart I (see Fig. 2) the largest number of injuries were to the eyes where PBI was considerably over the national average at 24% followed closely by hands at 22% and back injuries at 18%.

CHART I

ANATOMY OF PBI'S COMPENSABLE WORK RELATED INJURIES

(N= NATIONAL) (P=PBI)

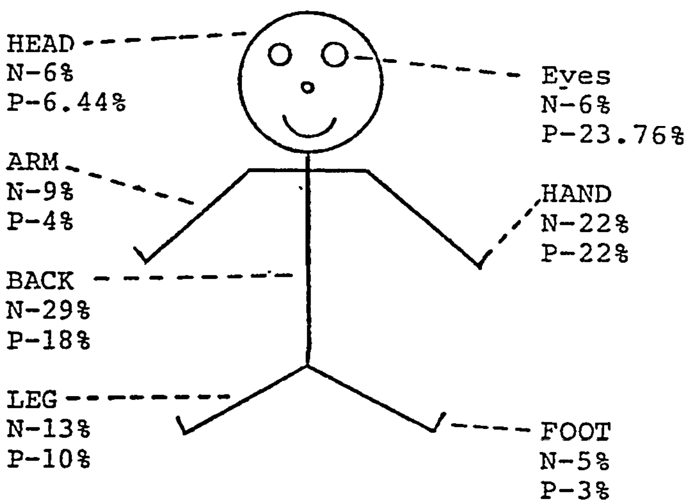


CHART II

1985 EYE INJURIES

MONTH	TOTAL	NURSE TREATED	DOCTOR TREATED
JANUARY	19	18	1
FEBRUARY	18	11	7
MARCH	37	32	5
APRIL	35	21	14
MAY	32	27	5
JUNE	33	27	6
JULY	33	24	9
AUGUST	41	31	10
SEPTEMBER	22	0	22
TOTALS	270	191	79

FIGURE 2

The Nurse's report for the last nine months of 1985 (see Chart II, Fig. 2) shows that there were 270 eye injury cases reported to her. Of these, 79 were treated by doctors. Each incident requiring a physicians care cost PBI approximately $100 for a total of $7,900. Each employee lost an average of two hours work time per occurrence or a minimum of $2,212 in lost wages. The remaining 191 cases that were handled by the nurse resulted in an average of 20 minutes lost time per occurrence or a minimum of $896 in lost wages. Given these figures, the eye injuries for the last nine months of 1985 cost $11,008.

79 Doctor cases	=	$7,900 in Doctors bills
		$2,212 in lost wages
191 Nurse treated cases	=	$896 in lost wages
		$11,008 Total

While investigating historical data the group decided to also initiate a study to determine exactly how far PBI was falling short in one facet of its goal to assure a safe work place, that of enforcing rules requiring all employees to wear protective equipment when in production areas. It was decided that all members of the Team would observe for one hour a day over a one week period and record violations. In order to not give the impression of being "company spies", the violations were recorded by trade with the aid of hard hat colors and department numbers (see Fig. 3). The results (see Fig. 4) indicate that over the course of the study there were 891 violations. This is not 891 different people, since duplications were undoubtedly recorded each day. Hard hat violations tallied the most with 368. Side shields followed with 331 and safety glasses with 192. Especially important to note is the total violations on the part of not only supervisors (blue hats) but salaried personnel as well (white hats).

The injury statistics told the Team indirectly that personal protective equipment was not being worn or was worn improperly. The results of the study clearly exemplified the extent of neglect on the part of supervisors and employees. With 9.2% of the violations recorded being supervisory (management personnel), the direction of the groups recommendations for corrective action was clear. It is difficult to expect workers to follow rules when the very people they look to for guidance and leadership are providing poor examples.

TRADE	DEPARTMENT NUMBER	HARD HAT COLOR
CARPENTERS	11	WHITE
FABRICATION	12	YELLOW
SHEETMETAL	13	GRAY
PIPE DEPT.	14	BLACK
OUTSIDE MACHINIST	15	RED & DK BLUE
INSIDE MACHINIST	16	RED & DK BLUE
ELECTRICAL DEPT.	17	ORANGE
FIBERGLASS	18	PURPLE
WELDERS	19	RED
ERECTION	21	YELLOW
QUALITY ASSURANCE	22	TAN
PAINT DEPT.	23	BLACK & YELLOW
INSULATION	25	PURPLE
LAMINATING	27	ORANGE & PURPLE
ALLOWANCE SECTION	28	YELLOW
TEST DEPT.	29	YELLOW
WAREHOUSING	31/32	YELLOW
RAW MATERIALS	32	YELLOW
WAREHOUSE - TOOL ROOM	32	PURPLE
MAT'L HANDLING	33	GRN & BLUE/BRN STRIPE
MAT'L HANDLING	33	BROWN
RIGGING	33	RED & BLACK
BUILDING MAINTENANCE	34	TAN
MACHINE MAINTENANCE	34	BROWN
PIPE MAINTENANCE	34	COPPER
ELECT - TELEPHONE MAINTENANCE	34	PURPLE & RED
INDUSTRIAL ENGINEERING	39	YELLOW
STAGING - VENT - DISP - JAN.	45	BROWN
LOFT - LAYOUT	88	GREEN & GOLD
CARPENTERS 11.2	11.2	GREEN

FIGURE 3

TOTALS	SAFETY GLASSES	SIDE SHIELDS	HARD HATS
20 white (11)	0	2	18
111 Yellow (12)	20	19	72
57 Gray (13)	5	15	37
72 Black (14)	19	31	22
44 Red& Dark Blue (15 & 16)	13	14	17
18 Orange (17)	3	3	12
4 Purple (18)	1	2	1
24 Red (19)	8	5	11
49 Yellow (21)	4	17	28
3 Tan (22)	1	1	1
27 Black & Yellow (23)	6	11	10
32 Purple (25)	9	9	14
57 Orange & Purple (27)	2	4	51
O Yellow (28)	0	0	0
8 Yellow (29)	2	4	2
15 Yellow (31/32)	5	3	7
18 Yellow (32)	8	6	4
22 Purple (32)	6	9	7
15 Gm. & Blue/Brown Stripe (33)	5	5	5
58 Brown (33)	20	36	2
0 Red & Black (33)	o	0	0
26 Tan (34)	13	11	2
10 Copper (34)	3	4	3
12 Purple & Red (34)	4	3	5
0 Yellow (39)	o	0	0
35 Brown (45)	7	26	2
6 Green & Gold (88)	o	3	3
22 Green (11.2)	4	2	16
26 White (Supervisors)	5	20	1
56 Blue	17	32	7
37 Navy	1	30	6
3 Non-Productive	o	3	0
4 Visitor	1	1	2
891 TOTAL	192	331	368

FIGURE 4

After considerable thought the Lifesavers agreed to recommend the following aids in the stricter enforcement of the safety policy by supervisors and employees.

1. Addition of the category of safety enforcement on the supervisors performance evaluation form.
2. Addition of safety awareness on the employees evaluation form.
3. Include **all** PBI property as a hard hat, safety glasses and side shield area except inside office area spaces.

These recommendations were formally discussed with management at a presentation given by the entire Safety Action Team. Those members of management who were invited to attend were

E. L. Peterson	President
J. Gagnon	Vice President and General Manager
E. Propsom	Vice President of Production
D. Washburn	Director of Marketing, Training and Safety
R. Russell	Production Manager
F. McGrath	Engineering Manager
F. J. Peterson II	Facilities Manager
B. Gerl	Personnel Manager
G. Karnopp	Warehousing Manager

The presentation was well received by those who attended and generally accepted by the following memo.

TO: SAFETY ACTION TEAM

FROM: E. PROPSOM

REF: LIFESAVERS SAFETY PRESENTATION

"As stated at the presentation, both Ellsworth Peterson and I have approved general acceptance of the program you presented. This acceptance includes:

1) Evaluating supervisors and employees on their attention to safety at time of wage reviews.
2) Strict enforcement of hard hat compliance as stated in the PBI manual.
3) Strict enforcement of glasses and side shield use throughout the yard.

A check on head injuries over the past several years indicates our present excepted areas have **not** contributed to the injury statistics, so it is considered counter productive and unreasonable, just to make a policy easier to enforce.

Because of the proximity of our offices separated by city roads and the traffic area known as the "blue line area" we will continue to have this an exempted area.

Although the hard hats will be exempted in the same designated areas, it is unanimously agreed that all areas including shops will require use of glasses and side shields. The only exceptions will be the office areas and those traversing in the "blue line" area between the main gate and the offices.

We believe your study was well done and appreciate your concern for compliance and enforcement. By enforcement of our present policy, along with clarification of certain areas, we feel we can meet our mutual objective of a safe place to work, earn and learn..."

Results from calendar year 1986's accident report did show a 43% reduction in the total number of eye accidents and a 39% reduction in doctor referrals for treatment of eye injuries. Clearly a significant improvement.

B. SAFETY ACTION TEAM PROJECT TWO: The Lifesavers second project appeared on their brainstorming list as "Material storage in Pickling Area of the Pipe Shop (chemicals)"; however, this actually reflected a concern for the proper storage and issuance of solvents yard wide. Their consideration was prompted by an incident where a new employee was overcome by fumes while working in an enclosed area. He had not taken the normal precautions of knowing what kind of solvent he was using or setting up proper ventilation. Either omission could have caused injury or death.

After some discussion the group ascertained that their project could be broken down into two distinct areas: (1) Information/Education and (2) Distribution/Disposal. The team decided to enlist the aid of the Quality Circles, and through the Facilitators, requested that each Circle record what hazardous substances were being used in their work areas. The Lifesavers compiled a similar list and noted how the substances were being controlled at that time. Additional data was gathered from other shipyards to gain an insight into what methods of control are most common.

The results of the in-house survey prompted the following conclusions:

a) Other than the Paint Shop, most departments should not need a large volume of hazardous substances.

b) No records were kept on amounts used or who used them.

c) Inadequate containers with no identifying labels were being used to distribute solvents.

d) Using the right solvent for each application would save money by cutting down on waste.

Using the information gathered by all the participants, the Team worked out a simple solution to part (1) Information/Education. A list of the most commonly used substances was assembled in the format shown below in Table A.

The Industrial Engineering Department was asked to assemble and maintain a library of this information on their Personal Computer. This, along with information such as flash points and precautions from the material safety data sheets, appeared to satisfy the informational requirements of the project. Education was provided by Safety Technician Dave Nieman. Over the course of a two week period Dave, with the aid of an audio/visual program, instructed all production supervisory personnel in the handling of hazardous material and the interpretation of material safety data sheets. Part two of the project, Distribution/Disposal, required considerably more effort.

TABLE A

SUBSTANCE	USE	TOXIC	FLAMMABLE	SHOP	CONTROLS
MEK	Paint thinner, paint equip cleaner cleaner	x	X-not for general use	#23	Dept. 23 use only, in shop use only.
Freon 113	Flush freon systems	X-toxic gas when exposed to open flame	x	#14/ #15	Pipe Shop use only.

Using solution analysis the Lifesavers attempted to generate a number of plausible solutions. From these, the group determined that there were seven issues that would have to be resolved in order for an overall control plan to work:

1) Some way of monitoring the use of substances would have to be incorporated.
2) A centralized, manned distribution center should be established.
3) Some departments may require a large volume of cleaner to prevent running for it every day yet control is needed so 55 gallon drums aren't scattered all over the yard.
4) Requirements for storage of small containers of the substances will have to be determined.
5) Second and third shifts will have to be controlled.
6) Disposal and control of used cleaning rags will have to be addressed.
7) Input from production supervision to incorporate their opinions/needs.

In order to make the best use of the time available, the team members each chose an issue to expand on with the end result being a written recommendation. These suggestions were discussed among the Team members. A questionnaire that highlighted the suggestions was circulated to all middle and upper level management personnel who would be affected requesting their opinions and comments. These responses were incorporated and the final drafts, which follow, were submitted to the Vice President of Operations, as a proposed operating procedure.

1) **Purchase of approved safety containers for storage and dispensing of the solvent.**

   The containers can be purchased for quantities of from one pint up to five gallons. These containers will have a metal tag with the number of the container for identification and type of solvent inside. The containers will be red in color and stenciled on the outside. Most importantly, the containers will meet applicable OSHA standards, which requires U.L. Listing or F.M. approval.

2) Incorporate a tool chip-for-container policy.

   In order for production personnel to get a container of general purpose cleaning solvent, a tool chip will be required to ensure responsibility for that container. This system would be identical to the chip-for-tool policy now in effect. If the container is not returned or is found unattended on the boat, proper disciplinary action can be taken. Under no circumstances will anyone be allowed to distribute the solvent in unapproved containers such as fruit cans, plastic bottles, etc.

3) **The Tool Room will be the distributor of the general purpose cleaning solvents.**

   The general purpose cleaning solvents will be stored in one or two quart approved containers in fire lockers in the Tool Room. These containers will be marked with metal tags and stencilled. They will be distributed, upon request, to production personnel for use on the job. When the containers need refilling, either Tool Room personnel or some other authorized person will take them to the Paint Shop to be refilled. There will be no need for large containers (55 gallon drums) of cleaning solvent to be stored in the Tool Room. This will be the only solvent for distribution from the Tool Room.

   The fire lockers in which the solvent will be stored should be located for easy accessibility in case of fire or emergency. Because the Tool Room is a wood frame building the lockers must be equipped with a self-contained extinguishing system and/or a safety fuse-link system either of which is thermally activated.

4) **All other solvents will be stored and distributed by the Paint Department.**

   Requests for distribution of solvents stored by the Paint Shop must come from the supervisor of the personnel requiring the material. The solvents will be dispensed in approved containers only and a chip from the employee picking up the solvent will be required. The only solvent out of direct control of the Paint Department will be the general purpose cleaning solvent stored in the Tool Room fire lockers.

5) **Purchase of approved rag disposal containers.**

   When oily rags are disposed of with solvent rags there could be an interaction between the two, creating an unsafe situation. By using approved disposal cans only, this situation can be prevented. The placement of these disposal containers will be left to the ship manager's discretion.

6) **Material data sheets displayed at the Tool Room.**

   A material data sheet explaining the properties of the general purpose cleaning solvent will be permanently displayed at the Tool Room. Pertinent information on the data sheet such as flash point, health information, what to do in case of an accident, etc. will be highlighted for the employee to take note of. Yard personnel, when picking up the solvents, will be required to be familiar with the solvent by reading the data sheet. Tool Room personnel will be conversant with this information and instruct employees requisitioning the solvent to take note of the highlighted precautions.

All of the Safety Action Team's recommendations were agreed to. The required equipment (approved containers and flammable storage lockers) was purchased, and the

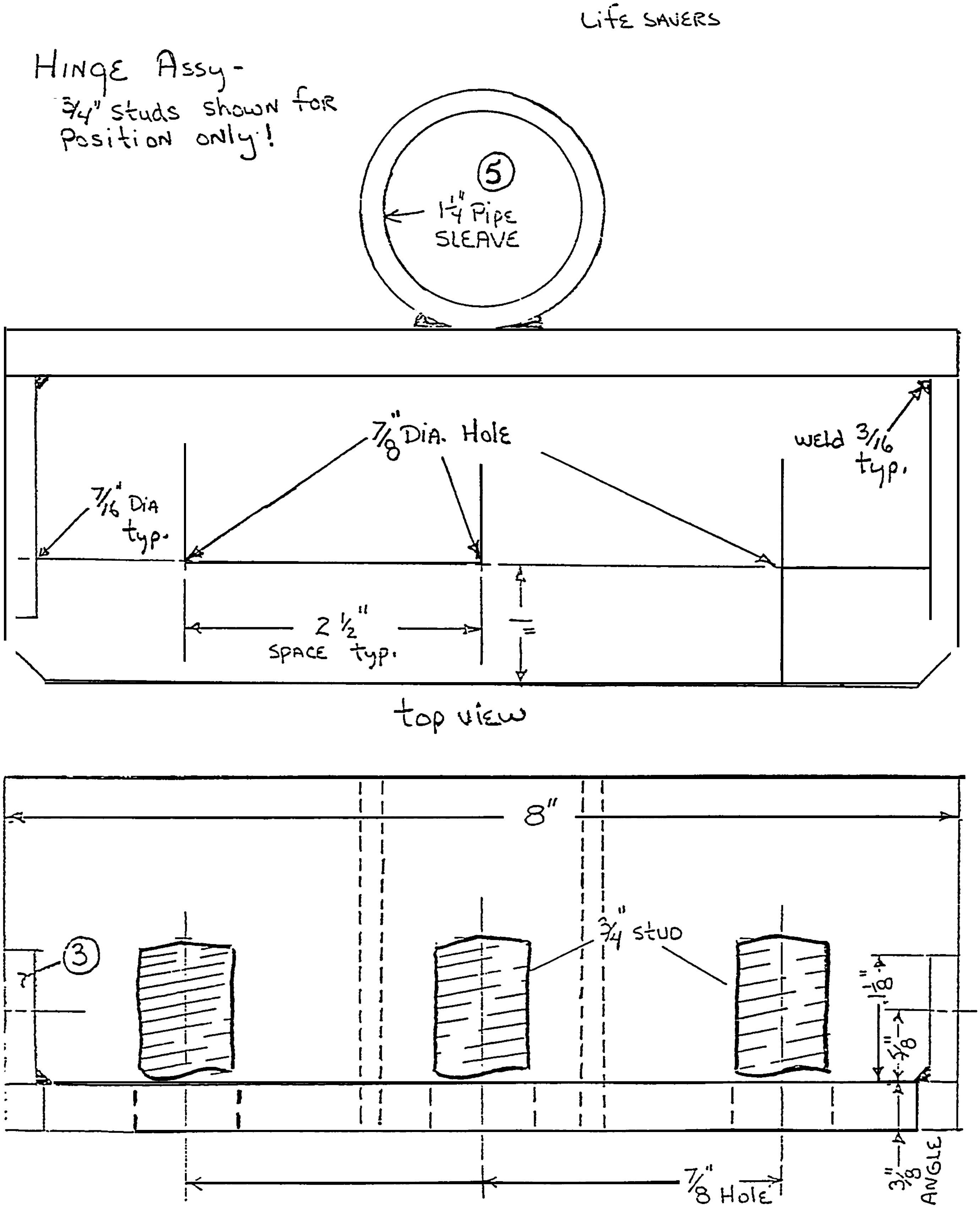

LIFE SAVERS
HINGE ASSY -
3/4" studs shown for position only!
5
1 1/4" PIPE SLEAVE
7/8" DIA. HOLE
WELD 3/16 typ.
7/16" DIA typ.
2 1/2" SPACE typ.
top view
8"
3
3/4" STUD
1 1/8"
5/8"
3/8"
7/8" HOLE
3/8" ANGLE
FRONT VIEW

Figure 5

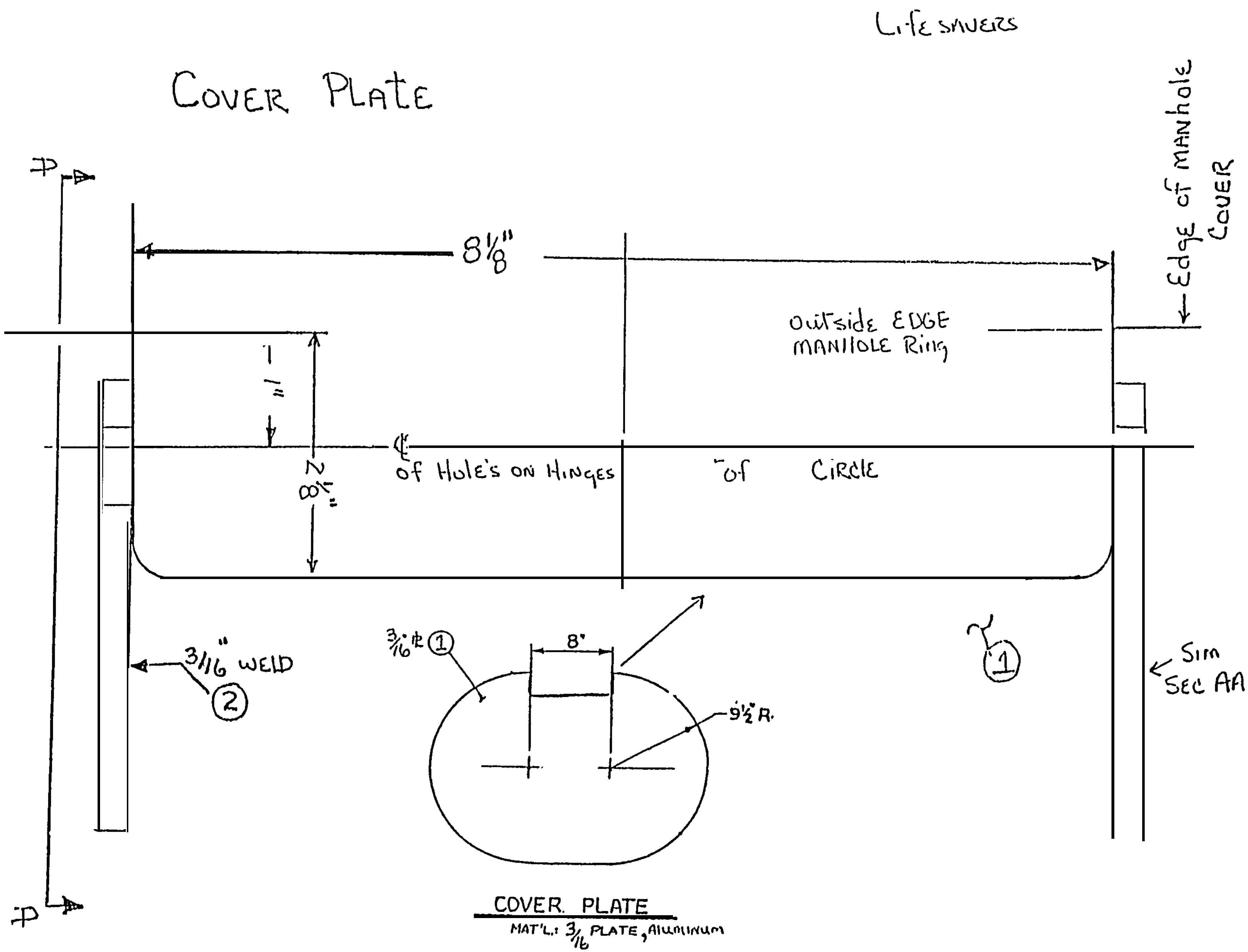

Lifesavers
COVER PLATE
A
8 1/8"
Edge of manhole COVER
Outside EDGE MANHOLE Ring
1"
2 3/8"
℄ of Hole's on Hinges ℄ of CIRCLE
3/16" WELD
2
3/16" ℄ 1
8"
9 1/2" R.
1
Sim Sec AA
A
COVER PLATE
MAT'L.: 3/16 PLATE, Aluminum

Figure 6A

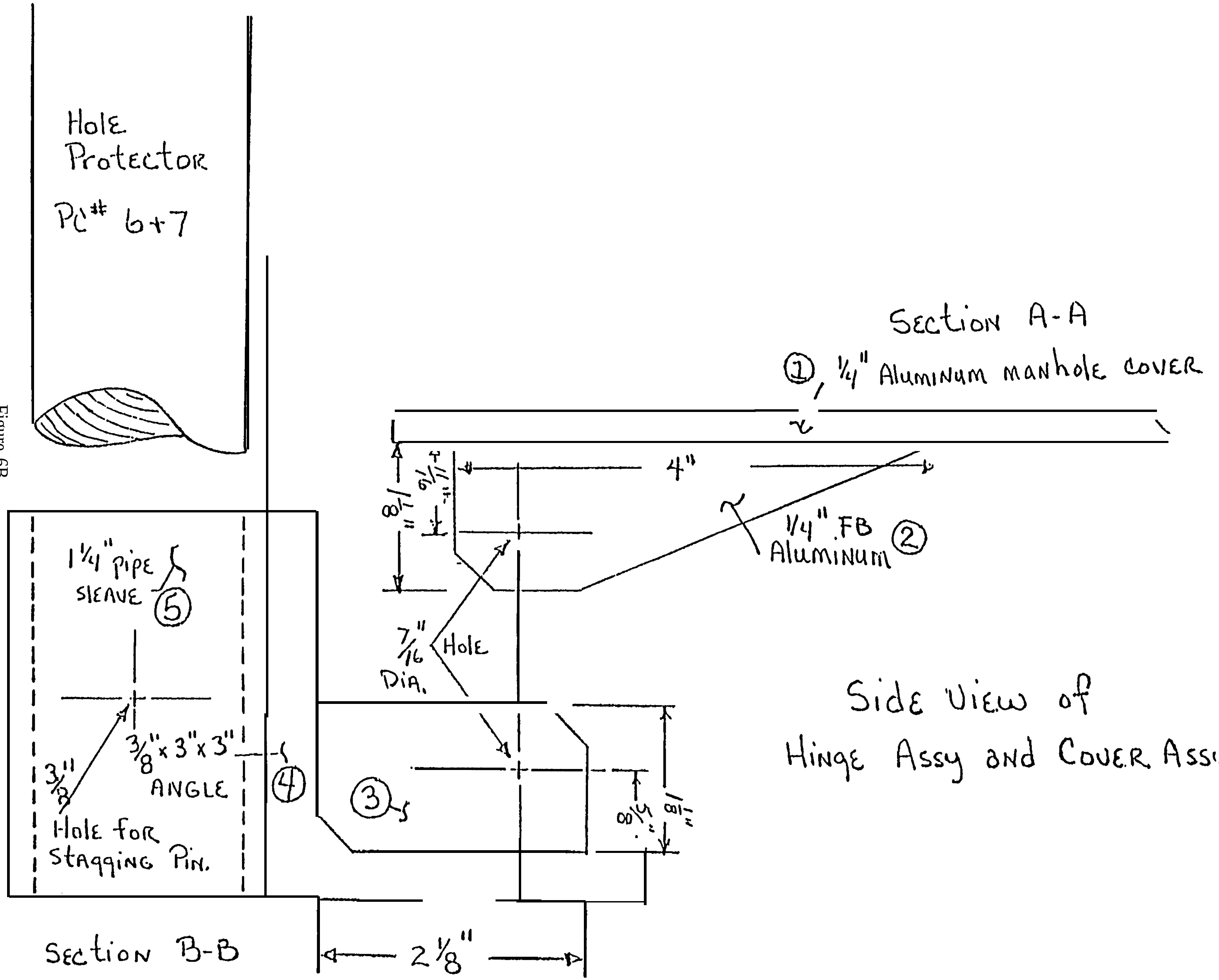

Hole
Protector
PC# 6+7
Section A-A
① 1/4" Aluminum manhole cover
4"
1/4" FB
Aluminum ②
7/16" Hole
Dia.
Side View of
Hinge Assy and Cover Assy
1 1/4" pipe
sleave ⑤
3/8"x3"x3"
Angle
④
3/8"
Hole for
Stagging Pin.
③
Section B-B
2 1/8"

Figure 6B

suggestions were established as a PBI Standard Operating Procedure. All employees were made aware of its implementation through the Company Newsletter and individual crew meetings.

The recent purchase of a hazardous waste reclamation still has somewhat complicated the issue and further investigation of the procedure will be required.

C. **SAFETY ACTION TEAM PROJECT THREE:** Manholes, scuttles and other small deck openings represent a potential hazard in all stages of ship construction. Many times these openings are heavy traffic areas or require periodic access. A temporary cover can come ajar allowing it, or a person stepping on it, to fall through. After looking at the problem, the Lifesavers sat down and designed a three part device that they felt was an excellent solution. When used together, the parts form a flexible hole covering system.

The unit has a central element referred to as a hinge base (see Fig. 5). This unit attaches to the deck or manhole ring through the use of bolts, studs or lags allowing use on steel, wood or aluminum hulls. As the name implies, the hinge base has hinges to which the second part of the system, a cover, can be fastened (see Fig. 6A & B). This securely positions the cover over the opening preventing it from falling through or being misaligned. A pipe sleeve is welded to the back of the hinge base which allows the third component, a ring stanchion, to be attached.

Once the hinge base is securely fastened in position, the two other components can be attached as needed.

The ring stanchion consists of a metal pipe and an oval shaped ring which, as a unit, slides into the pipe sleeve on the hinge assembly. A metal staging pin is inserted at the base to prevent the ring from pivoting to one side. When used with just the hinge base it allows unrestricted access to the deck opening while preventing someone from inadvertently stepping into it. An additional benefit is that the ring serves as a handhold when moving through the opening. The ring is useful in areas that must remain open because of heavy traffic, hot weather or running large ventilation hoses. It does have its limits as it is impractical for confined spaces or where obstructions exist. As a result, a second method of protection is employed; the manhole cover.

The standard cover was designed to fit most manhole openings. It was constructred out of ¼” aluminum to be light yet durable. The hinges are welded to one side and cannot come loose like the temporary wooden covers now in use. The aluminum cover has two positions in which it can be mounted. The first allows it to set flat to the deck at the same level as the hinge base. This provides a tight fit when trying to keep heat in. The second position is obtained by turning the cover over before mounting. This raises the cover up so that it will ride flat on the studs of a common raised manhole. This is useful because it allows cables or small hoses to be run in between the studs while the cover remains closed. When used with the ring stanchion, the cover can be latched in the open position to prevent it closing on unsuspecting personnel.

Self locking nuts on the bolts that attach the cover to the hinge assembly allow smooth operation without the chance of the nuts falling off.

The itemized cost for each ring stanchion and cover is as follows:

12” X 3” X 5” X ¼” steel angel @40c/lb	=	$3.20
30” Sched 40, 1¼” steel pipe @$l .20/ft	=	$3.00
5‘ Sched 40, 1" steel pipe @$l.05/ft	=	$5.25
3.56 sqft or ¼“ X 19” X 27” alum plt @$l.80/ft	**=**	**$6.30**
Labor to bend pipe @40/hr for ½ hr	=	$20.00
Labor to cut alum plt @$30/hr for ¼ hr	=	$7.50
Labor to fab and weld @$30/hr for ½ hr	=	$15.00
Self locking nuts and bolts	=	$3.85
		$64.10

D. SAFETY ACTION TEAM PROJECT FOUR: The Lifesavers fourth project, deck congestion, was probably their most ambitious. If not for the success of their first three undertakings it is unlikely they would have tackled it. The group felt it was (1) a problem that adversely affected the output of all production trades, (2) important to our principle client, the Navy, and (3) a definite safety hazard.

The first step the Team took was to contact various sources to find out what methods have been tried, whether successful or not. One Team member contacted the local Navy office. The Industrial Engineering representative made inquiries of a number of other shipyards and several Team members looked into ideas that had been tried in-house over the years. The information obtained showed that deck congestion was considered a normal side effect of ship construction and, other than the use of small cable “hangers” and cable “trees”, no effective system was in use.

A brainstorming session to verbalize the goals and objectives of the project was the Lifesavers next step. The list was considerable:

1) Reduce tripping hazards.
2) Improve traffic flow.
3) Increase production.
4) Improve fire safety.
5) Reduce damage to hoses and cables.
6) Reduce injuries and time loss.
7) Improve housekeeping.
8) Present a neat professional image.
9) Cost savings.

10) Reduce number of hoses and cables that are needed.
11) Reduce the need for pull back of hoses and cables.
12) Increase the life of hoses and cables.
13) Reduce congestion through doorways.
14) Improve morale by having a more pleasant work environment.
15) Reduce the time spent cleaning up before trials.
16) Produce a system that will be useful on all contracts in all phases of construction.
17) Produce a hanger that is not a “head-knocker”
18) Make it easier for people to do their jobs.
19) Isolate the electrical and welding cables from the hull.
20) Make it easier for facilities people.
21) Produce a procedure for enforcing hanger use.
22) Reduce the danger of unplugging air fed respirators.

During tours of the hulls under construction and subsequent discussions, the Lifesavers determined there were a number of interrelated problems contributing to the deck congestion issue. A lack of devices for containing and routing service leads was evident. Types which were available were of an inferior design. No system or plan was in use for good placement. PBI also lacked coordination between set up, distribution, and safety.

With these issues in mind, five items were determined to be the most important aspects of a long term solution. First, a cable hanging system should be developed to get lines up off the decks. Second, the system must be adaptive to various areas on present ships, as well as future contracts. Third, the system must be expandable so that it can grow to parallel production needs. Fourth, it must provide for the safe entrance and egress of service leads through the ship; and fifth, it needs to be easy to set up and service and be convenient for the workers onboard.

In order to encompass all of these requirements, the Safety Action Team decided to split their project into four distinct phases: development of safety design items, establishment of a preplacement plan, assignment of clear cut responsibilities, and education.

DEVELOPMENT OF SAFETY DESIGN ITEMS

Cable Hangers: On a recent PBI commercial contract a cable hanger was designed to help keep service leads out of the way of production workers. Unfortunately, this overhead T-type of hanger had a few inherent weaknesses which limited its adaptability to other contracts. It was built to be attached to structural members only. It could only be oriented in the same direction as the structural member it was mated to. Most service leads need to be arranged longitudinally while most structures run transversely. In addition its firm attachment means it will not move if bumped by a persons head or it it needs to be shifted slightly for compartment installation.

After the Lifesavers analysis of the T-type hanger they came up with a number of alternatives. A prototype was constructed and experimented with briefly on the last ARS hull. This provided an opportunity to fine tune the unit and incorporate a few minor changes which resulted in the finished design (see Fig. 7).

This design has a number of favorable points:

1) It is adaptable to many types of structures. It can be tied, clamped, nailed or screwed to any structural member with sufficient strength irrespective of the direction in which it runs. This will allow use on steel as well as aluminum or wood contracts.

2) It is electrically isolated from the hull structure when natural or synthetic line is used for hanging. If a weld cable or electrical line is damaged and comes in contact with the hanger it will not ground out to the ship.

3) Subtraction or addition of cables is relatively simple. A separate area is created in the upper quarter to accommodate the primary service leads into the ship. The other space is used for the multitude of individual cables needed to construct the ship.

4) Its shape is relatively nonaggressive. There are no sharp protrusions into the passageways. As it is being supported by a line, it will float or flex a bit when bumped. This also allows it to be swung out of the way to some extent if it is interfering with some component installation.

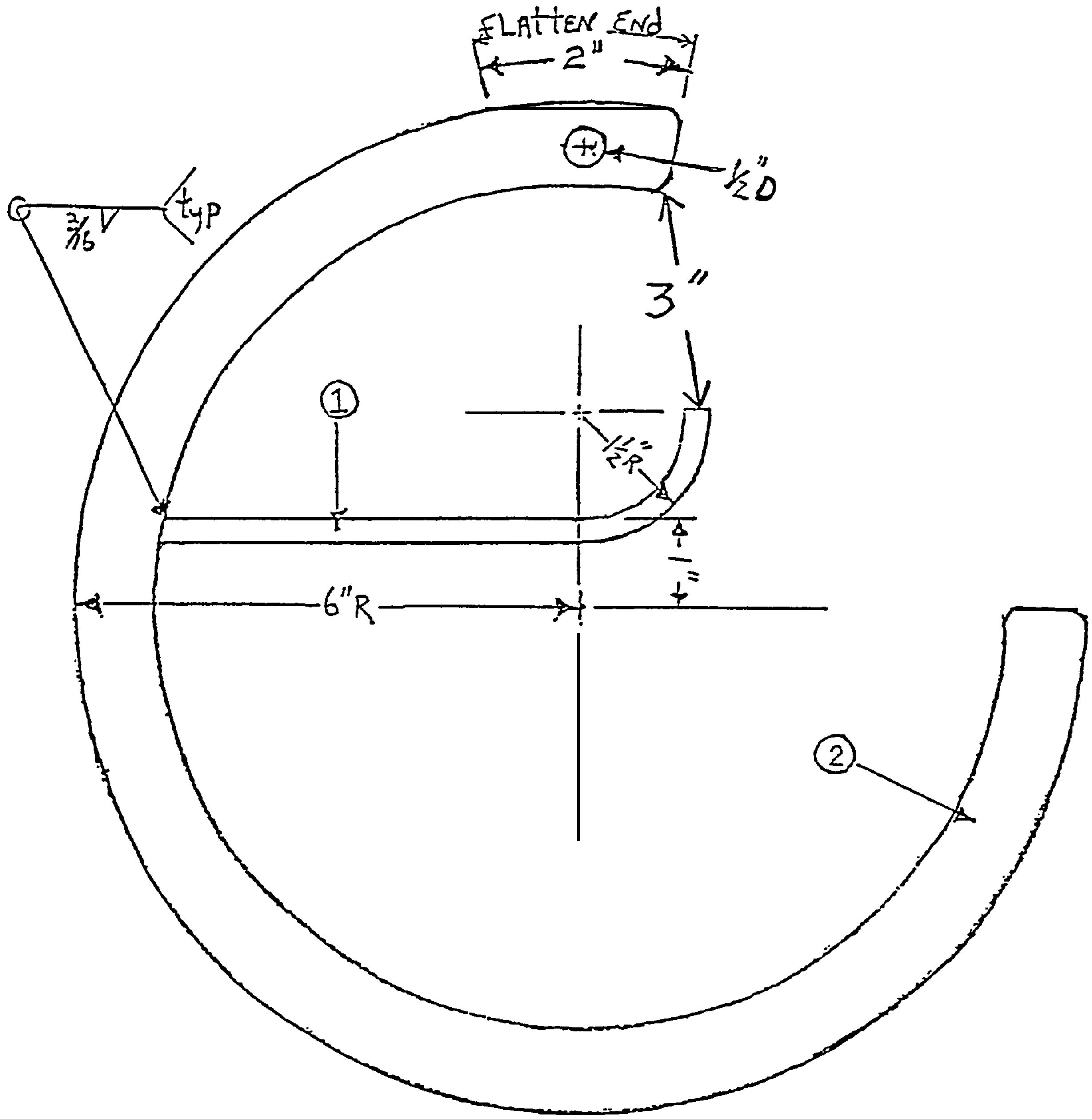
5) The hanger is an easily rolled shape, formed from common material and requiring a minimum of welding. All of which simplifies construction and keeps costs down. (Estimated cost with materials and labor $20/unit.)

Cable **Trees:** Deck congestion problems exist not only in passageways but also in exterior areas such as weather decks. Because of the absence of overheads these situations must be handled differently. The cure for this problem was already available, the use of cable trees.

These cable trees (see Fig. 8) were originally built to get service leads from the dock to the ship. The majority of them were standing idle and those in use were not being fully utilized. The Lifesavers determined that it would take approximately five of these units per hull to set up an effective system.

The general design was adequate for the Teams purpose but they added pad eyes to each tree to facilitate easy lifting on and off the ships. In order to reduce the cost of fabricating more of the trees, the old T-type hangers were utilized as the top portion of the new units. (Estimated cost of time and materials $100/unit.)

CABLE HANGER



PC. No.	
1	3/8" Round BAR 7½ Long - steel
2	3/4" sch 40 pipe 29½" Long - steel

Figure 7

CABLE TREE

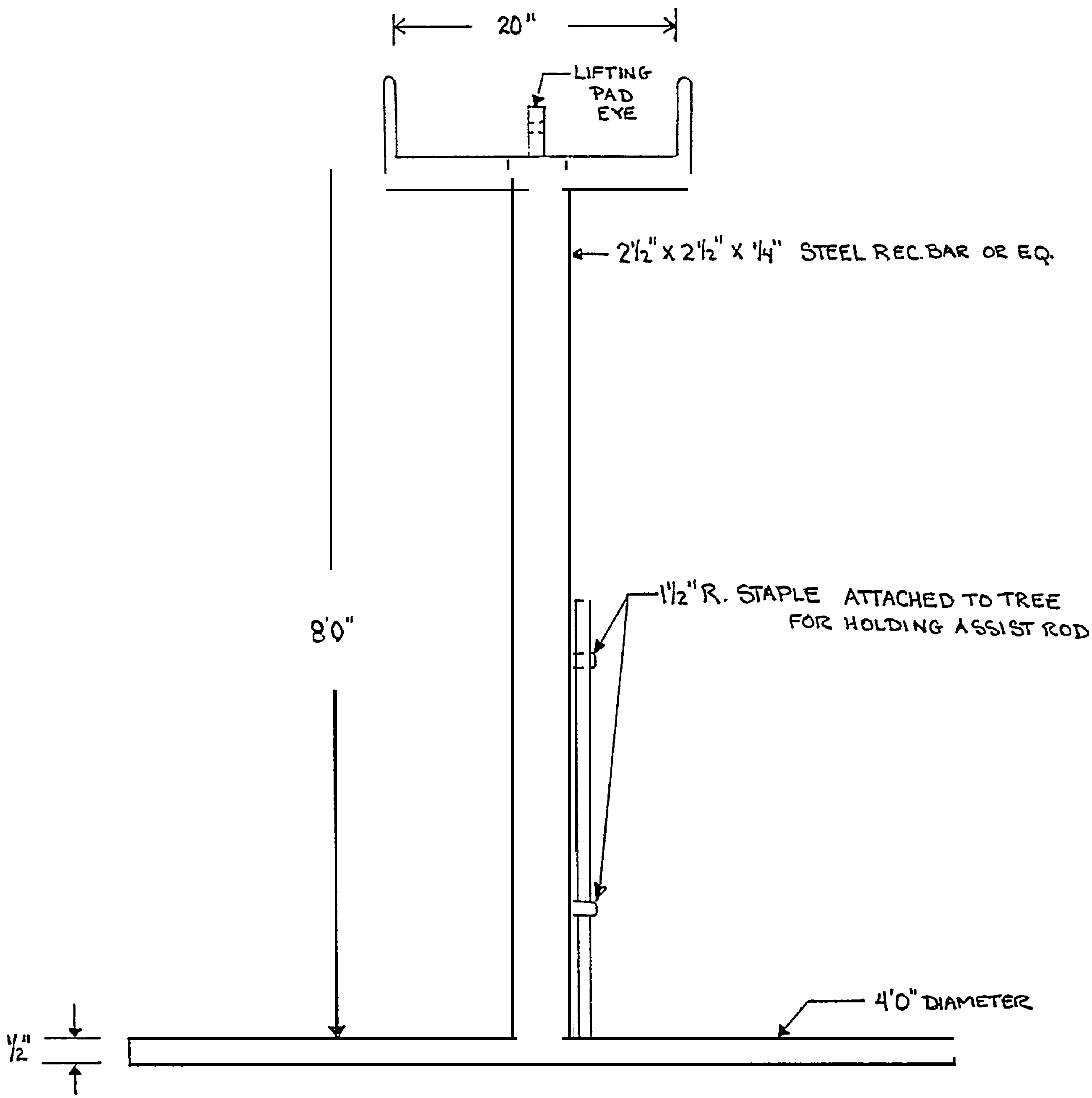


Figure 8

Since the finished trees were approximately 8‘ tall to allow for safe passage of men and equipment it was feared that workers would not use the units because of difficulty in placing the cables in the “baskets”. A device consisting of a wooden broom handle with a “U” shaped prong attached to one end was fabricated to accompany each tree. Wood was chosen to act as an insulator against possible electrical shock.

Some advantages of using these trees instead of simply allowing service leads to lay on the decks are:

1) Reduce injuries by eliminating tripping hazards.
2) Reduce potential fire hazards involving cables and hoses.
3) Increase the working life of supply lines.
4) Keep electrical cords and boxes from laying in water.
5) Improve housekeeping and appearance.
6) Increase productivity by eliminating need to constantly move service leads while doing deck work.

As with the cable hangers, to realize these advantages to their fullest, preplacement planning must be done to eliminate interferences.

Stanchion Hangers: Another tool which the Lifesavers developed to aid in solving the deck congestion problem was a stanchion hanger. This is a device designed to allow service leads to run onboard without the adverse effects of sagging lifelines or abnormal cable wear and abrasion that results when these leads are run over the lifelines.

The unit pictured in Figure 9A & Figure 9B has a shallow socket that slips over either temporary or permanent stanchions while leaving the chain ring exposed so that the life line can still be run without interference. Since excess lengths of service leads and unused leads are contributing factors in cluttered decks, these hangers also offer a place to store the excess or idle cable.

Additional advantages are:

1) Serves as an aid to good housekeeping in maintaining a safe work environment.
2) Helps to maintain proper height of lifelines to satisfy OSHA requirements.
3) Extremely easy to install and use.
4) Fabrication is simple and inexpensive (time and materials estimated at $25/unit).

Electrical Service **Leads:** Electrical service leads laying in water or dirt on the decks is both a housekeeping and a safety problem that stringing them in overhead devices does not entirely solve. Soon hangers become so filled with cables that they actually contribute to the congestion.

60 AMP supply panels are set up at random, usually in passageways. Workers require two, sometimes three 25’ extension cords to bring power to the compartment they want to work in and often leave the cords lay after completing the job. Soon the panel resembles a rats nest and eventually circuit breakers blow, disrupting production.

Clearly, the cable hangers would not be effective unless the electrical supply problem was improved. After discussions with the Electrical Maintenance Department and production workers, the Lifesavers determined that if receptacles and 60 AMP power panels were strategically located for easy access, the number of extension cords used would decline dramatically.

The solution selected was to fabricate new electrical leads in 25’ lengths with two double receptacles per cable. One would be located at the extreme end of the cable and the other at the mid point. By running these electrical leads in the cable hangers, while at the same time using a larger number of well placed 60 AMP supply panels, readily available plug-in sources will be close to the work areas. Long term plug-ins such as string lights, although run in the cable hangers, were plugged directly to the 60 AMP panels on their own circuit to reduce the change of overloading. Productivity improves by reducing the workers set up time and safe working conditions are enhanced by eliminating potential hazards. These advantages easily outweigh the cost of $49.90 per cable.

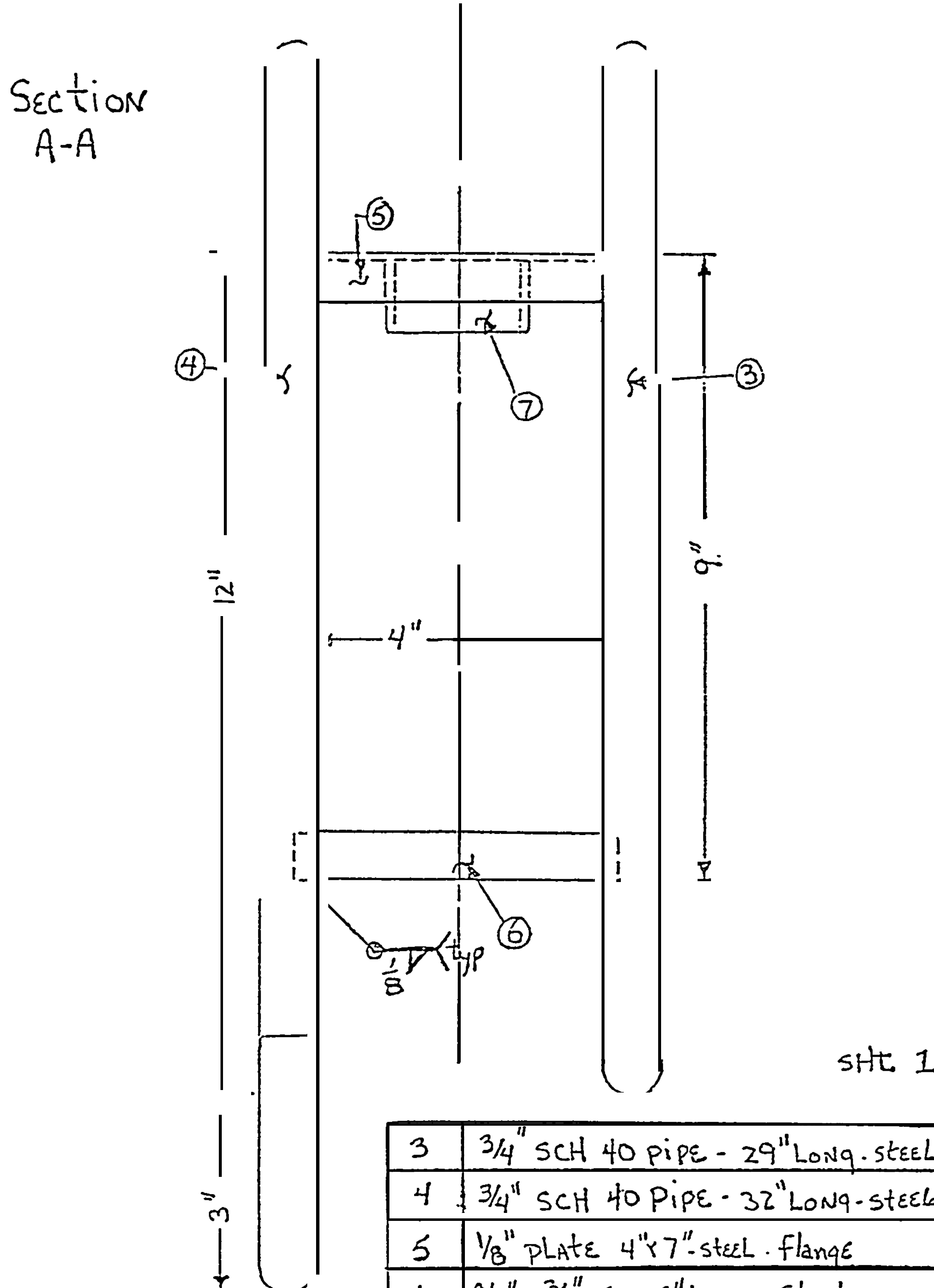
Air Supply Service Leads: A problem similar to the one with the electrical leads existed with the air supply service leads. The Team’s goal on this portion was not only to get these leads off the deck but to try and reduce the number needed.

The large 2” air supply lines were being run to two manifolds, one fore and one aft. As with the electrical leads, workers required several lengths of hose to reach their work site. The resulting tripping hazards were considerable as was the amount of lost production time being wasted on looking for these $^3/_4$” hoses.

With the parallels to the electrical lead problem, it’s not surprising that the solution the Lifesavers arrived at was similar.

The Team began by again soliciting input from production personnel as well as making their own on site evaluations. They kept in mind the requirements mentioned earlier; those of safety, adaptability, expandability and easy use and maintenance. After considerable discussion, numerous rough drafts and a review of materials on hand, they came up with their final ideas.

STANCHION HANGER



SHT. 1

3	3/4" SCH 40 PIPE - 29" LONG - STEEL
4	3/4" SCH 40 PIPE - 32" LONG - STEEL
5	1/8" PLATE 4"x7" - STEEL - FLANGE
6	3/16" x 3/4" - FB 5" LONG - STEEL
7	2" SCH 40 PIPE 1" LONG STEEL

RP

Figure 9A

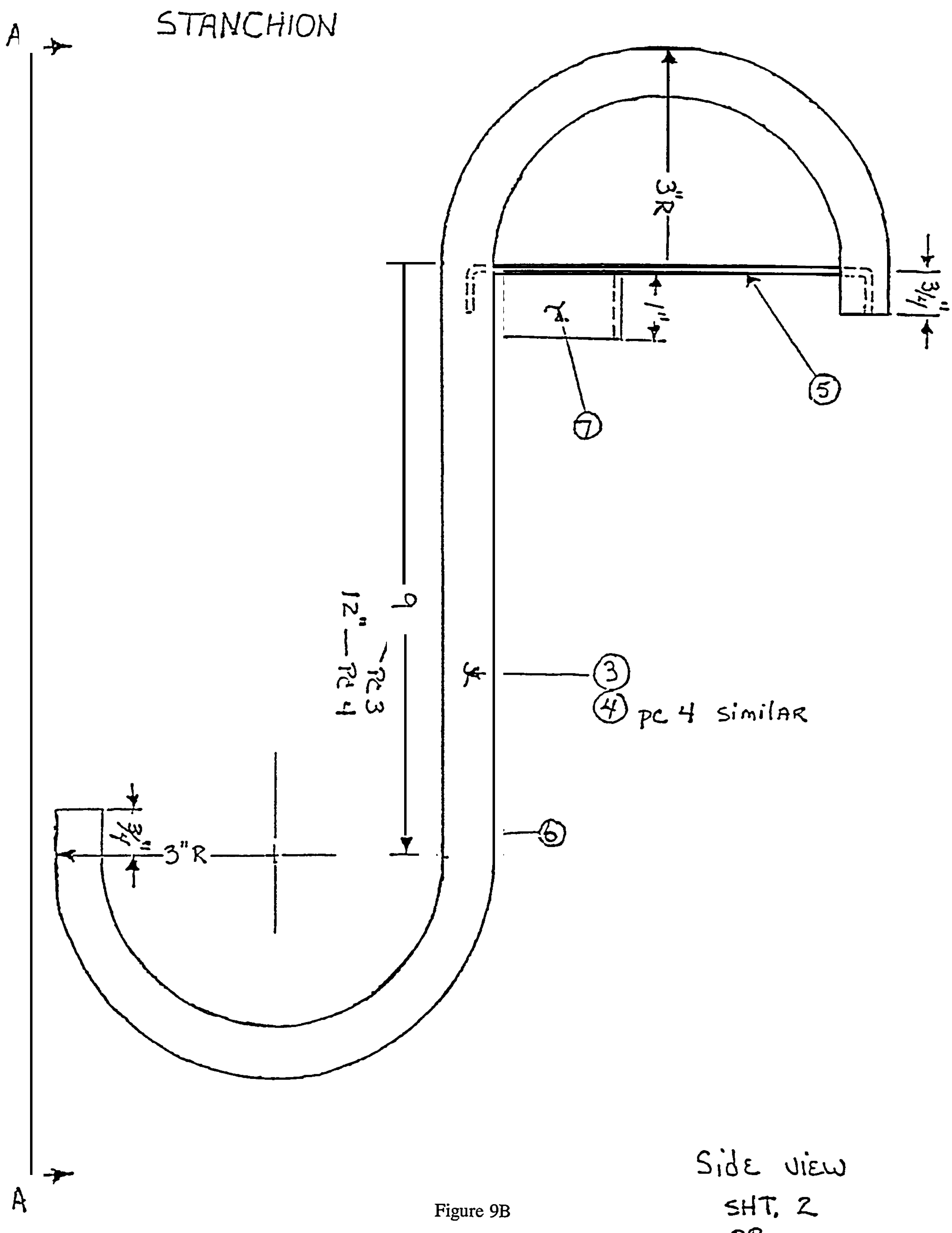

A
STANCHION
3"R
1"
3/4"
7
5
7
9
12" — PC 4
— PC 3
3
4 PC 4 similar
3/4"
3"R
6
A
Side view
SHT. 2
R.P.

Figure 9B

The first element was a smaller supply line that would fit easily in the cable hangers. 1¼" air hose was selected because of its flexibility, weight and availability. In order to make the supply line system easy to expand, the 1¼" hose was cut to 25' lengths. These sections were joined by fabricated air line tees equipped with shut off valves (see Fig. 10). By using these valves the system was not only easy to add to and repair, it also had the benefit of being able to be quickly disconnected at any joint for material installation, say an interior bulkhead, without having to pull back the entire line. Because the whole system doesn't have to be shut down during these interruptions, there is a minimum of production disruption.

At every air line tee, a 6' length of 1¼" supply hose was branched off for a drop to the deck. Here, specially fabricated mini-air manifolds (see Fig. 11A & Fig. 1lB) were attached. These manifolds were designed with a base plate for stability, a pet-cock type condensation drain and six air chucks. By having one of the mini-manifolds located every 25' along the entire run of hose, workers have a readily accessible air source and greatly reduce the production time loss that was usually encountered when hunting for lengths of air whips and the constant safety hazard created by hoses running to only two sources.

When the three components, 1¼" air supply lines, fabricated tees and mini-manifolds, are joined together and arranged in the cable hangers as shown in Figure 12 a safe, effective air supply system is created. One air line unit consists of: 1 - 25' air hose, 1 - 6' air hose, 2 mini-manifolds, and 1 fabricated tee. The cost of each of these units is $335.60.

Ventilation Spools: While the conditions previously listed cover most of the sources of deck congestion, there is one major item remaining, ventilation hoses. Due to the bulkiness of these hoses they cannot be placed in the cable hanger but by tying the hoses to hangers or other items overhead much of the problem is solved.

We are still left with one question, access to the hulls. The usual procedure is to run ventilation hoses through access doors along the decks. The method the Safety Action Team proposed was to use portholes as an alternate route and they developed an attachment for that purpose.

Figure 13 shows how one style of ventilation spool was designed using sheet metal in stock. First a 21" diameter base plate is cut out and holes are drilled around the perimeter that match the bolt pattern of a typical 17" diameter port light. Next two tubes are formed, one 8" diameter and one 5" diameter. Matching holes are cut into the base plate within the 17" diameter area that corresponds to the porthole opening. The tubes are inserted and tacked to the base plate. Lastly, caps that fit snugly over the end of the tubes are fabricated and permanently attached to the base plate with a short length of chain or cable. These assure a weather tight seal when hoses are attached. Other variations were also developed, some with only one tube or for mounting in larger openings.

There are many benefits to using these ventilation spools beyond the safety aspect. When hoses are run through doorways there is no way to properly seal the openings and heat loss is considerable. The spools eliminate this needless energy waste. There is less opportunity for damage when hoses are properly strung. Installation is simple and can be done when the port lights are cut out and drilled. The actual glass inserts can be left in storage until the ship is ready for trials thus eliminating possible damage and rework. Masking material and manhours can be saved by the Paint Department when preparing to blast and paint. During the warm weather months the caps can be left off the spools and provide natural ventilation. These same accesses can be used for running other cables and hoses when not needed for ventilation.

The price breakdown of the ventilation spools is as follows:

Material, sheet metal	$2.00
Labor to fab @$30/hr	=
Estimated Total Cost	

Because of the advantages listed above and the simple design of the unit, it can be very cost effective when used properly. (The Lifesavers were unable to document proof of energy savings.) As with all of the safety design items, reduced accident occurrences can not be ascribed to an individual device but must take into account the system as a whole.

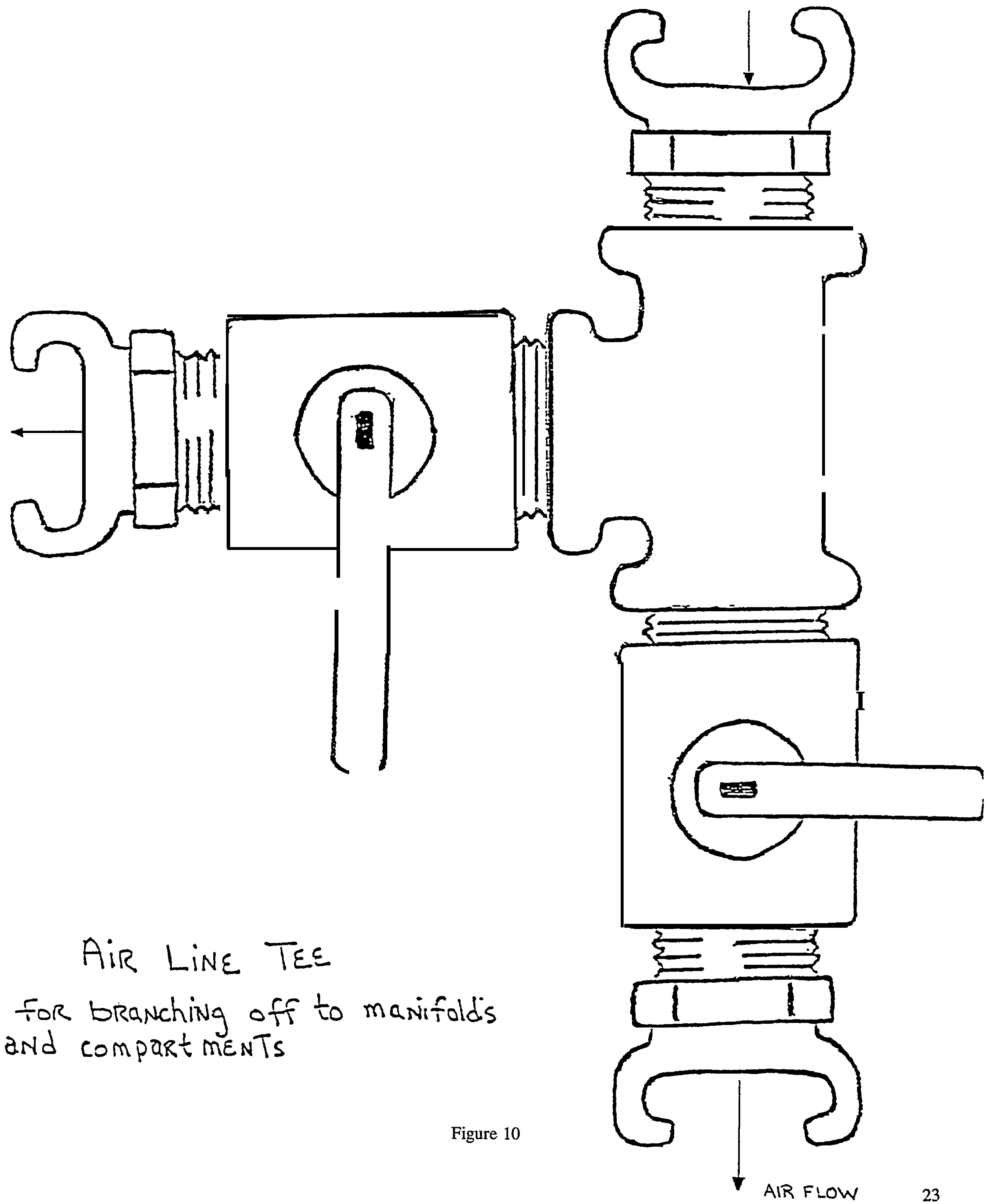

Air Line Tee
for branching off to manifolds
and compartments
AIR FLOW

Figure 10

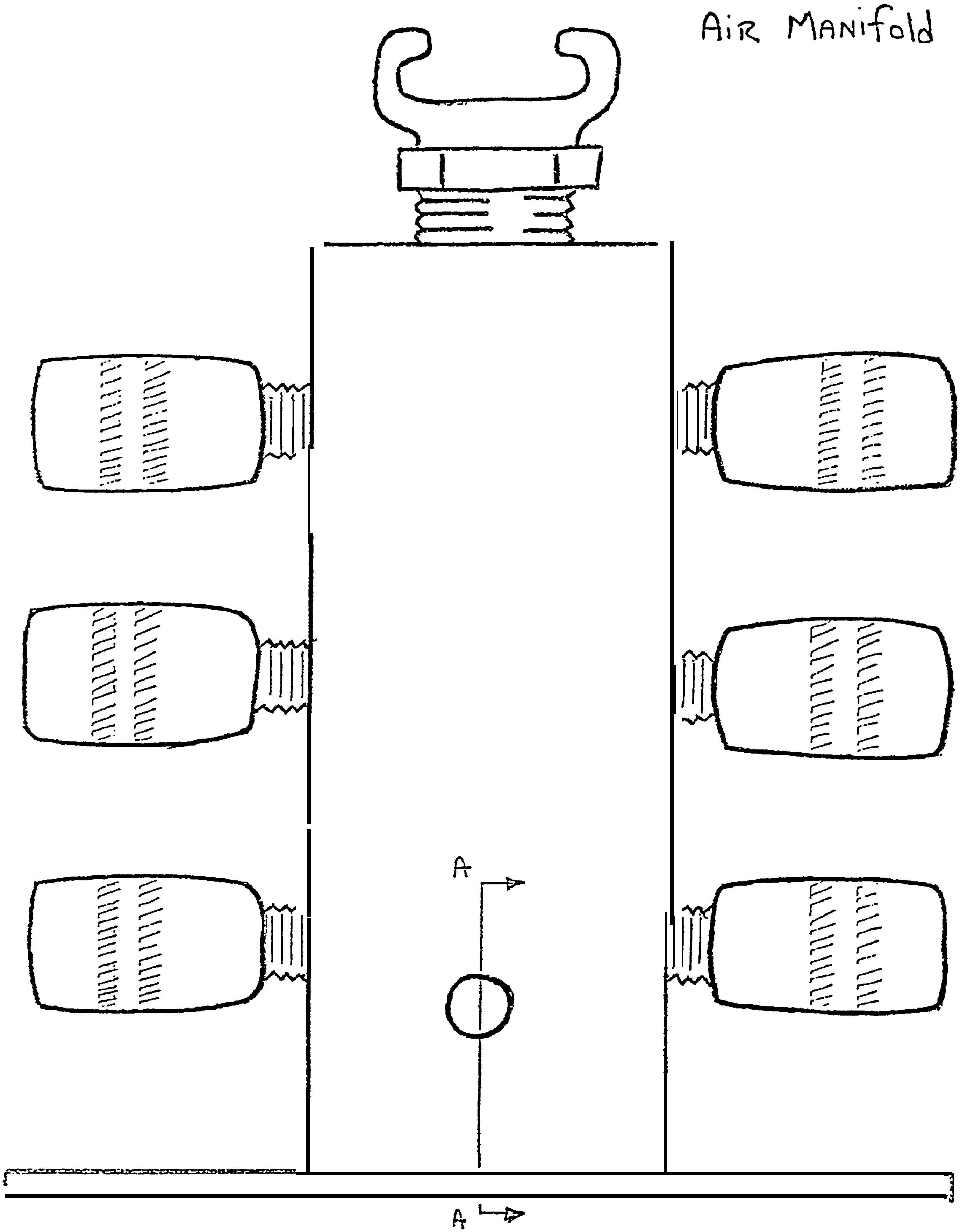


Figure 11A

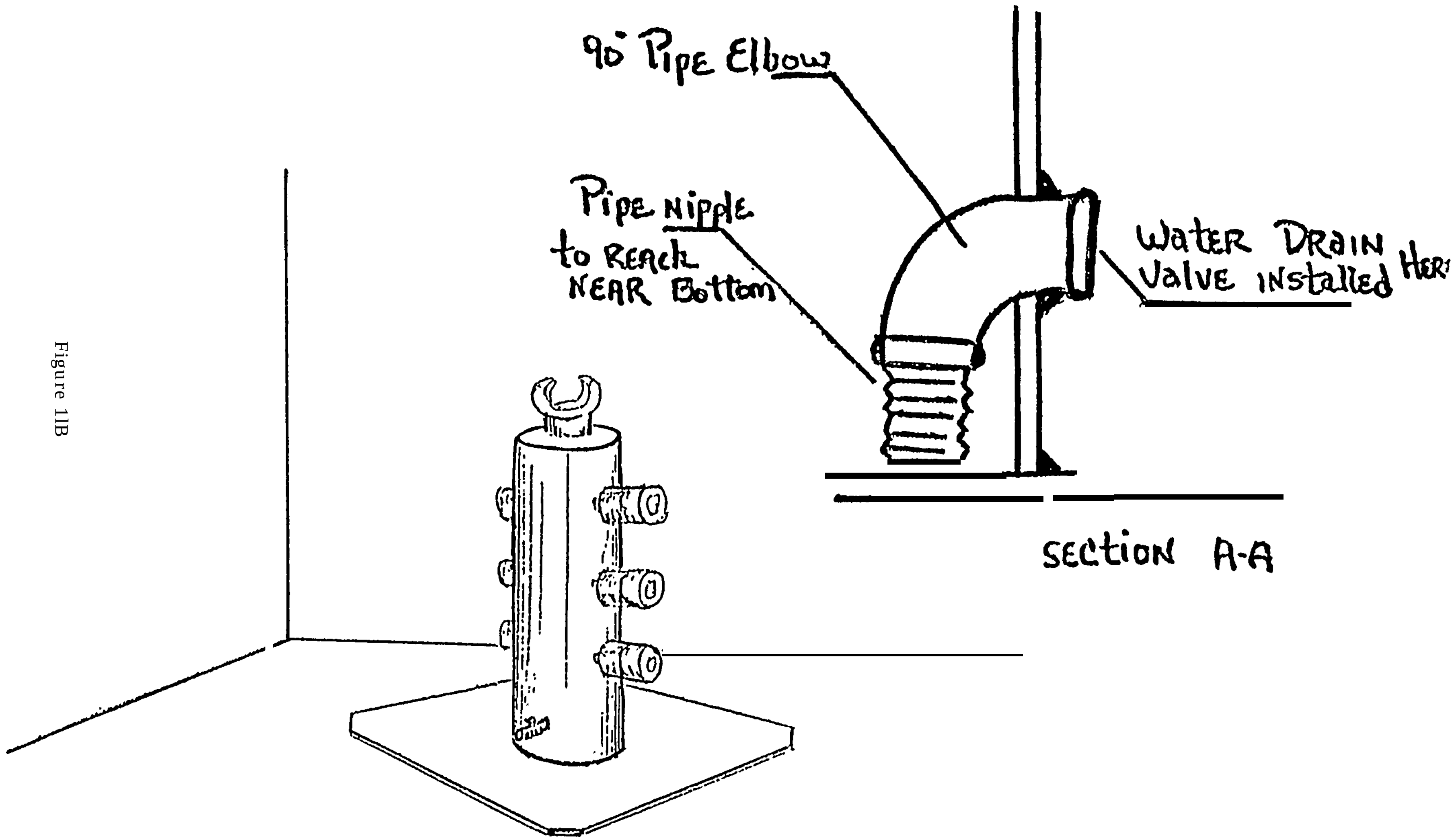
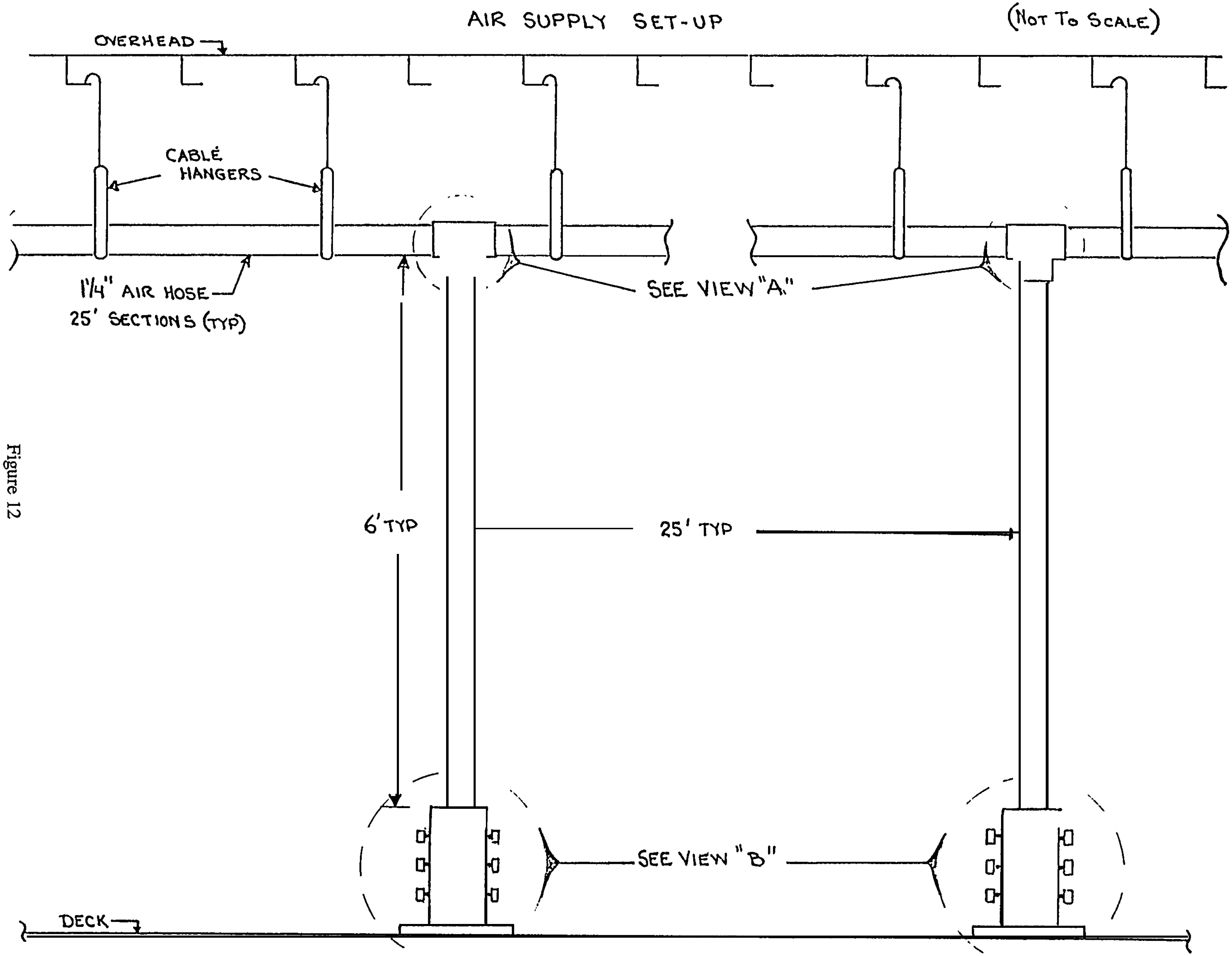

90° Pipe Elbow
Pipe nipple to reach near bottom
Water Drain Valve installed Her
Section A-A

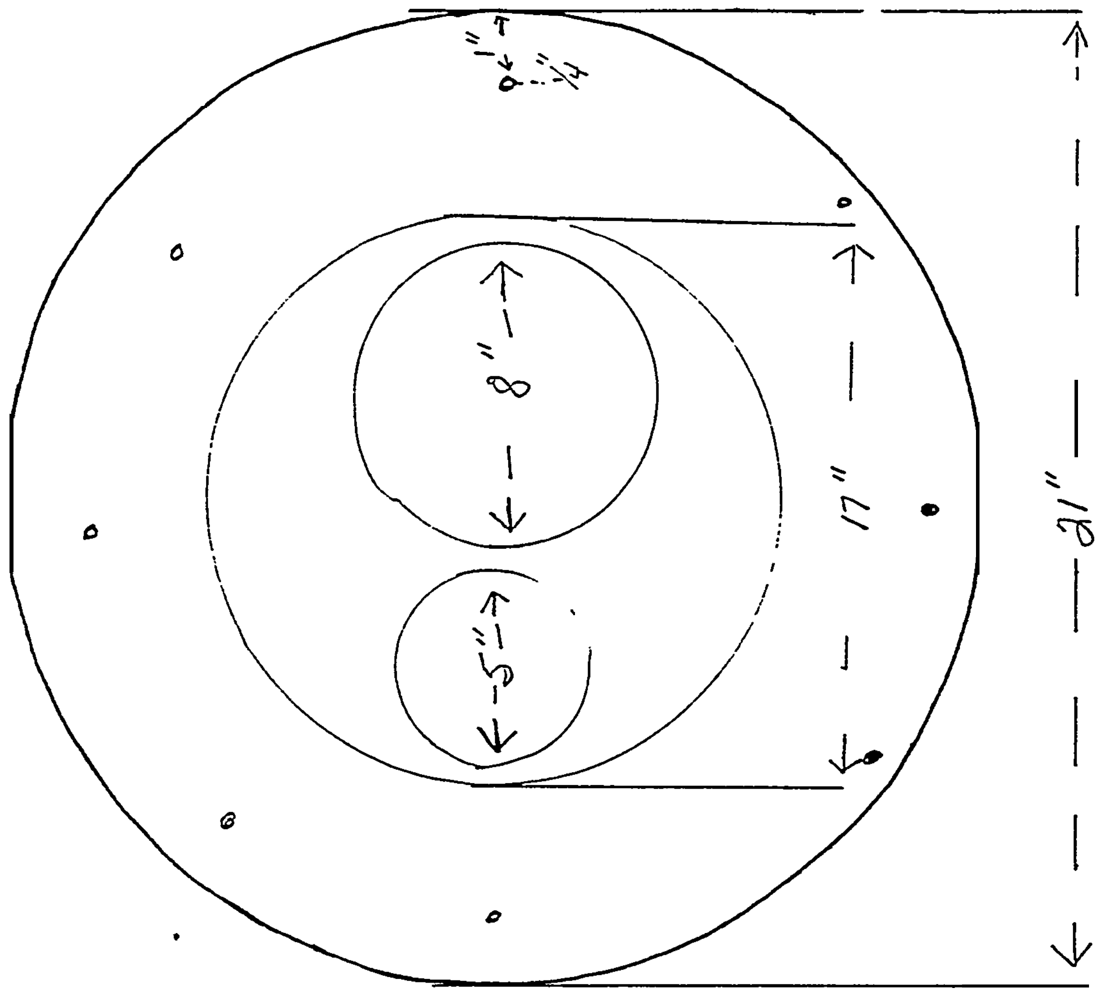
Figure 11B



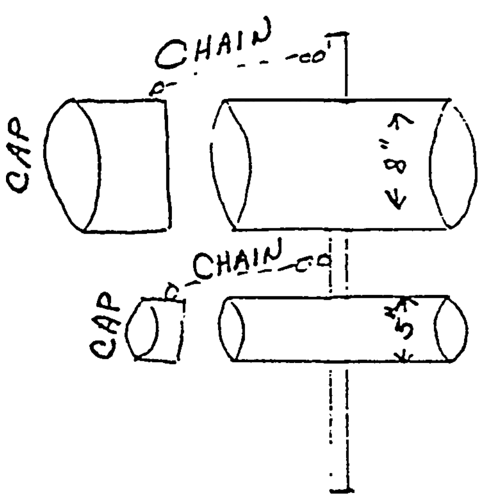
AIR SUPPLY SET-UP
(NOT TO SCALE)
OVERHEAD
CABLE HANGERS
1¼" AIR HOSE
25' SECTIONS (TYP)
SEE VIEW "A"
6' TYP
25' TYP
SEE VIEW "B"
DECK

Figure 12

MCM VENTILATION SPOOL FOR 17" PORTHOLES



SIDE VIEW:



8" OPENING FOR VENT. HOSES
5" OPENING FOR SERVICE LEADS

4 of each

T. SRENASKI

Figure 13

SECTION VIII

PREPLACEMENT PLAN

A. Establishment of Plan: After a number of each type of safety device had been fabricated they were installed in various areas on an ARS hull to test out how well they functioned under actual working conditions. Minor modifications were made in response to suggestions from production workers. Each of the safety design items proved that it can contribute to improving the deck congestion problem, but to realize its full potential, a sound preplacement plan must be developed.

The Lifesavers were aware that giving everyone who will be affected by an innovation some say in its development increases its chances of successful implementation. They accomplished this by soliciting input from ship managers, construction trade supervisors, production workers, maintenance supervisors, the facilities superintendent and Quality Circle members.

After determining the approximate amount of air and electrical service required, as well as zones of heaviest use, the Team began to rough-out their placement plan. Taking deck drawings of the MCMs and using lengths of string to represent the 25' electrical and air leads, the Lifesavers gradually developed a workable routing plan (see Fig. 14). They took advantage of deck openings such as exhaust trunks to drop to lower levels without cluttering access ladders and stairs. With the aid of a well thought out plan such as this, the department doing the installation has a predetermined location for hoses, electrical cable and 60 AMP supply panels. This eliminates guesswork and results in an organized and efficient system that can be easily expanded to accommodate production demands. Copies of the final preplanning layout were laminated in plastic for distribution to trade supervisors, ship managers, superintendents, the production manager, and a well traveled location on each hull under construction. This preplanning prior to installation of temporary services reduces production costs, eases congestion and by improving housekeeping, promotes safety on the job.

B. Assignment of Clear Cut Responsibilities: The Lifesavers believed that in addition to the lack of well designed safety devices and no planned system for set up, the failures of previous solutions to deck congestion were from a lack of clarity in responsibility. No clear cut guidelines for taking charge had been established. They felt that unless these responsibilities were clearly defined and assigned to individuals, their system was doomed to failure or mediocrity at best. This impression resulted in the development of what the Team called the' 'key man" concept. There are "keys" to the success of any program and this one was no exception.

Using the insight the Lifesavers gained while researching this project, they determined that the designated key man should be someone from the Facilities Department. The main reason for this choice was that storage, maintenance and installation of shipboard service equipment was already a part of facilities. As the "key" man term applied here, it would be his responsibility to delegate and monitor the necessary activities within the Maintenance Department.

Since there were no "clear cut" boundaries between work areas within hulls, the Team felt that supervisors should be collectively responsible for the system and promote correct usage by their subordinates after the initial installation. In addition, the shipboard trades would be responsible for providing feedback to recommend improvements and notification when expansion is necessary. The key man and the ship manager must coordinate the trades to achieve successful results.

The ship manager should play an important role because it is his responsibility to keep his ship clean and free of congestion per written PBI Standard Procedure. The condition of the ship would include the running of service leads in a safe manner. The ship manager must demand, through individual supervisors, that the production workers use the system correctly and all other members of management must emphasize their commitment to the success of the program.

The Safety Department needs to continually monitor and evaluate the use and effectiveness of the system and provide timely reports to the key man so that he can implement the appropriate corrective action.

With one person in charge, given clear responsibility and management's determination to succeed, along with the ship manager's coordinating efforts and daily monitoring by the Safety Dept. and production supervisors, the program is effective.

After the Safety Action Team had developed the first three phases of their solution to the deck congestion problem, they presented the recommendations to the following members of management: the President, the

Required Units

3 - Electrical Panels.
3 - Electrical Feed Lines
2 - Air Feed Lines
16 - 25' Electrical Cables
15 - Air Lines with Manifolds every 25'

■ Electrical Panels
● Supply Down
— — — Air
——— Electrical

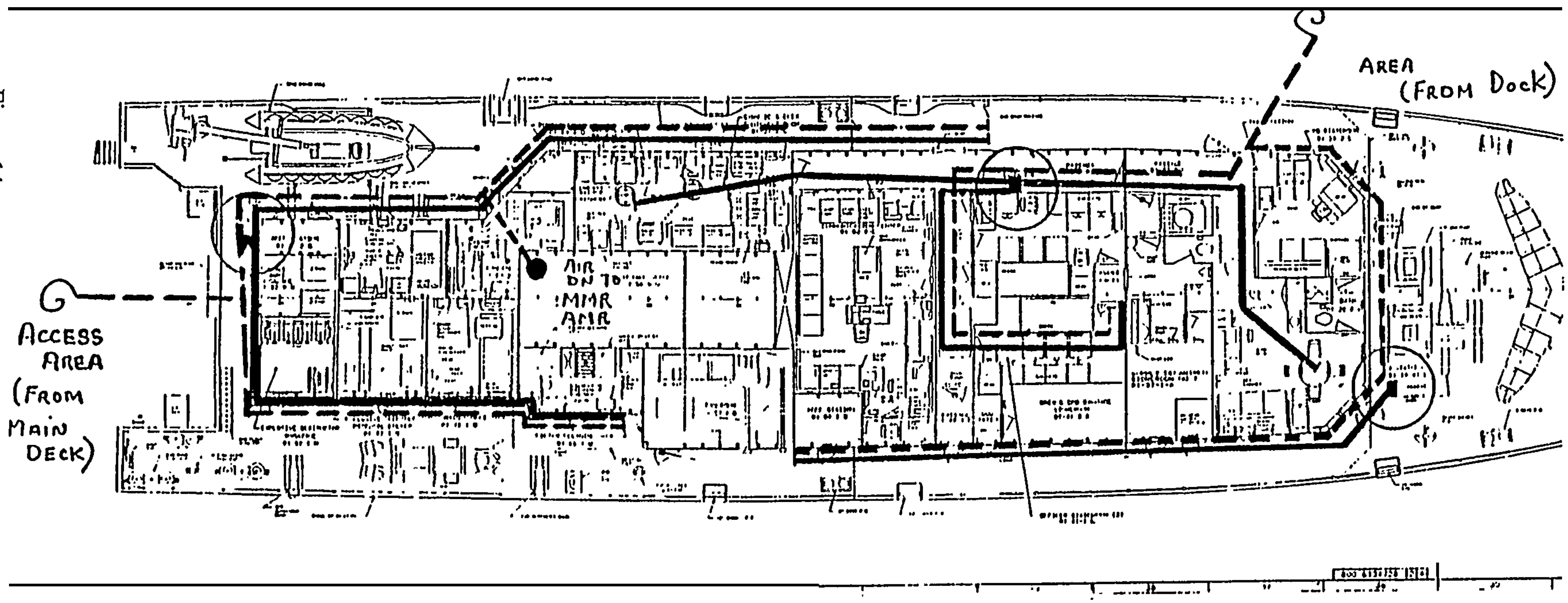


Figure 14

Vice President of Production, the Production Manager, and the Facilities Manager. To fully explain their proposal the group used a variety of visual aids as well as data on costs for implementation and typical injuries. Still photos of a number of congested areas illustrated the severity of the congestion workers encounter and a demo section using all the components was displayed in the front of the room.

The overall operational plan that the Lifesavers drafted and recommended was as follows:

SECTION IX

Recommended Procedure for the Placement, Use, Maintenance and Enforcement of the Cable Hanging System and Devices

A. Preplanning Placement Stage: In order to have an effective system for the routing of service leads there must be a preplacement planning phase for the locating of all cable hanging devices. The purpose of the planning phase is to reduce the movement of these devices throughout the construction stage.

The preplacement planning should be done by a committee of people to include:

Ship Managers.
All shipboard construction supervision which would include foremen and/or leadmen.
Electrical maintenance personnel.
Air supply maintenance personnel.
Temporary services personnel.

Use of compartment and access drawings (C/A drawings) will assist the Preplanning Committee in deciding the optimum location for the cable hanging devices.

During the preplanning stage some considerations that should be discussed are

- Consider the use of any hull penetrations to be used as access for service leads into engine rooms and other areas below main deck.
- Consider the use of bulkhead penetrations or approval of temporary cutouts in bulkheads for passage through of service leads.
- Plan layout placement of hangers in subassembly stage or after rollover but before the joining of sections.
- Plan layout of hangers from bulkhead to bulkhead throughout the boat.
- Plan location of cable trees to minimize interferences with worker traffic and movement of equipment, but still be located for most feasible routing of service leads.
- Decide the number of cable hangers, cable trees, stanchion hangers, air and electrical leads required per hull.

This preplanning placement stage should take place at the earliest possible time to ensure that the hanging devices are in place and ready to use when the trades start construction.

B. Placement of Hangers, Air Manifolds, Power Panels, Stanchion Hangers and Cable Trees:

- Initial installation of hangers and trees is to be done by the Staging Dept. The installation will be done according to the preplacement plan developed earlier. This plan must take into consideration the dockside and/or construction area supply capabilities and the location of these supply needs - air, electricity, oxygen, and acetylene. Construction sequences must be made available for the initial planning to be practical.
- After the initial installation is complete, additions to, subtractions from, and movement of small numbers of hangers will be the trade supervisor’s responsibility. Any large scale or major changes will be handled by the Temporary Services Dept. The ship’s manager will request and direct major changes.
- With the use of the construction sequence plan, placement should be made using the most practical structural members, pipe and electrical hangers and penetrations to eliminate movement as much as possible.
- Cable trees must be placed where they will be used most effectively but cause the least amount of interference with construction. Movement of the trees must be kept to a minimum.
- Storage of all hangers, both cable and stanchion, and cable trees will be handled by the Temporary Services Department. This department will be required to maintain the inventories and request additions to the inventories as needed.

— Maintenance of electrical service leads, power panels, temporary lighting and etc. is to be handled by the Electrical Maintenance Department.

— Air lines, manifolds, etc. are to be Placed, stored and maintained by Pipe Maintenance Department.

C. Cable Hanger Utilization and Maintenance Procedure

— Dock plans will be made available to indicate availability of service air, power and oxygen/acetylene service to the ships.

— Ship construction sequence would be outlined to determine which areas onboard would best be served by overhead hangers and service leads.

— Organizational meetings to establish actual service lead placement would be arranged by the ship manager. These preplacement planning meetings will be with construction and trade supervisors who will have input for final placement.

— Leads horn the dock will be brought onboard with the thought to evenly distribute service through the cable hangers. The use of bulkhead, shell and deck penetrations will be determined at this time.

— Hanger placement would beat a spacing to prevent excessive sagging of cables and lines. Normal spacing will be from 4‘ to 6‘ apart.

— Hanging of the cable hangers will be from available structural members including pipe and electrical standoffs where their attachment will not excessively interfere with the installation of that system.

— Hanger storage when not in use would be under the control of the Temporary Services Department.

— Upper rung of the cable hangers are to be used for the more permanent service leads such as air, electrical and oxygen/acetylene lines leading to manifolds.

— A CABLE/LINE PULL BACK SHOULD BE SCHEDULED ON A WEEKLY BASIS TO PREVENT THE CLOGGING OF CABLE HANGERS WITH UNUSED LINES.

D. Cable Trees:

– Cable trees are to be placed onboard the ships at the direction of the Preplanning and Placement Committee.

— The trees are to be placed and utilized on all open areas of the boats where services are called for. They are to be used to bring the services from dockside to the enclosed areas of the vessels.

— Cable trees are to be placed at the most convenient locations to allow for free movement of workers, machinery, and equipment.

— Cable trees should be spaced to eliminate sagging.

— Cable hanging assist devices are to be used for placement and removal of cables/lines into and out of the cable trees.

— Installation and maintenance of the cable trees will be the responsibility of Temporary Services. If a tree has to be moved or repaired, this department should be contacted.

E. Air Service Leads:

— Air service leads are to be run throughout the ship in the specified cable hangers, cable trees, and stanchion hangers.

— Air manifolds are to be placed at 25’ intervals to reduce the amount of air lines running throughout the boat.

— Air manifolds are to be located in such a manner as to give the worker a quick, short route to the air supply.

— There will be one set of air service leads designated for each level. This will eliminate the need for running service leads from one deck to another.

— The 1¼“ diameter main feed air line is equipped with shutoff valves for both manifold and main feed line for ease of maintenance and also for isolation of the problem area for continued use of the line if possible.

— Installation, storage and maintenance responsibilities will be with the Temporary Services Department.

F. Electrical Service Leads:

— Electrical service leads are to be used to distribute power from the 60AMP panels to all areas on the boat for use by the trades.

— The electrical service leads will run through the cable hangers, cable trees and stanchion hangers.

— The leads will be 25’ long with plug in boxes spaced at 12½” intervals. This will reduce the need for long extension cords to get power from the panel to the work area.

— STRING LIGHTS ARE NOT TO BE PLUGGED INTO THE ELECTRICAL SERVICE LEADS.

— To eliminate overloading, when one service lead is full and there is a need for another, an extension cord is used to run from the 60 AMP panel to where the other service lead ended. Then continue with another electrical service lead.

— Repair and/or replacement of damaged electrical leads will be left to the discretion of the Electrical Maintenance Department.

— Installation of electrical service leads will be the responsibility of the Electrical Maintenance Department.

— There will be one set of electrical service leads designated for each level. This will reduce the need for running electrical service leads from one deck to another.

G. Stanchion Hangers:

— Stanchion hangers have been designated to provide storage for unused and excess lengths of service leads as well as for routing cables over and along the lifelines.

— The required amount of stanchion hangers will be determined by the Preplanning Placement Committee for initial placement. Others may be needed and will be made available throughout the construction phases.

— Installation of the stanchion hangers will be the responsibility of the Temporary Services Department.

— The stanchion hangers are to be placed where service leads are running onboard ship over existing lifelines, along decks where service leads can be stored, and inside the ship where stanchions are being used to guard an opening.

— The ship manager will observe daily that the stanchion hangers are being used properly. The Safety Department will also monitor their use and effectiveness.

— Final responsibility for installation, maintenance and storage of safety design items to be vested in the designed key man; in this case the Assistant Facilities Manager to whom all maintenance and temporary services supervisors report.

H. Enforcement of Policy:

— Enforcement, in order to be effective, must be accomplished through the immediate supervisor. PBI's disciplinary action policy is as follows:

- employee counseling or oral warning,
- written warning,
- three day suspension,
- discharge.

— Each supervisor is responsible for his men and for the manner in which they run their cables, hoses, etc. Therefore, each supervisor must be held accountable for the actions of his men and the condition of all service leads.

— The condition of the ship under construction is the responsibility of the ship manager. The ship manager has the authority to require that passageways be kept clear of hoses, cables, etc. at all times.

— The Safety Department will inspect the ships and report to management regarding the condition of these ships under construction.

— The ultimate responsibility for the safety and health of the shipyard rests with management. Management must insist that PBI is maintained in as safe a condition as possible.

The Facilities Manager volunteered his assistant manager to be designated the "key man" for the project. The operational write-up was then formally made a company policy and included in the files as PBI Standard Operation Procedure #46.

I. Education: During the presentation to management the Production Manager requested that the Safety Action Team conduct an informational session for all supervisory personnel, from leadmen through department heads and include ship managers. It was the general consensus of upper management that the Lifesavers had sone such a thorough job of developing and presenting the system that they were best equipped to field any questions that might be raised during the briefing. This became the final phase of the project, education.

Using the same general outline and props from the upper management presentation, the Lifesavers went through an explanation of the development and implementation of the cable hanging system. Twenty-four supervisory people were in attendance representing all production trades. The session was videotaped so that any new supervisors who would need to be brought up to speed could receive an overview at their convenience. Copies of the procedure and laminated deck plans of the system layout were distributed. Again the presentation was well received and acknowledged to be an excellent solution to a nagging problem.

The production manager closed the session by expressing total support for the project and tasking the supervisors with the responsibility of instructing their crews in its proper use.

SECTION X

CONCLUSIONS

The criteria upon which the effectiveness of the Safety Action Teams efforts must be judged is the accident rate at PBI. The following comparison of the rates from 1985 and 1986 speaks for itself.

1. Reportable Accidents
   1985 -17.9 per month
   1986 -14.3 per month
   20% reduction
2. Lost Time Accidents
   1985 -5.2 per month
   1986 -2.4 per month
   54% reduction
3. Lost Time Days
   1985 -59.6 per month
   1986 -33.3 per month
   44% reduction
4. Eye Accidents
   1985 -30.5 per month
   1986-17.25 per month
   43% reduction
5. Doctor Referrals
   1985 -24.7 per month
   1986-20.25 per month
   18% reduction
6. Doctor Referrals - Eye Related
   1985-6. per month
   1986 -3.8 per month
   39% reduction
7. Strains/Sprains
   1985-8.89 per month
   1986 -10.6 per month
   19% increase

With the exception of the last category a significant reduction in accidents has occurred. Equally encouraging from a production standpoint is the improvement in lost time days. Experienced employees are remaining at their stations doing their job rather than spending time in the Nurse's Office. The time wasted looking for hoses and electrical cords has also been affected positively. A brief study done by one of the Quality Circle groups had determined that 11.1% of the time wasted looking for commonly used items was for cords and hoses. A follow up study currently under way shows this figure has been reduced to less than 5%. Possibly when the cable hanging system is up and functioning on all hulls the number will be reduced even more.

Factors such as employment levels may have affected these figures but to what extent is unknown. It is the firm opinion of PBI's management that the Lifesavers Safety Action Team has played a meaningful role in the reduction of accidents and improving overall safety awareness at PBI. They have been encouraged to continue finctioning as long as there is an active interest shown. The group will become part of the Quality Circle Program and continue to direct their efforts exclusively to the improvement of shipyard safety at PBI. The Professional Safety Magazine reports that in 1984 workers suffered a disabling on the job injury once ever 17 seconds. It is our goal to keep our employees from contributing to this statistic and with their help we can achieve it.

APPENDIX
DISCUSSION PAPERS

PAPER NO. 1 SUBMITTED BY J. H. HOOKER PRODUCTION DEPARTMENT NORFOLK NAVAL SHIPYARD

1. As requested, I have reviewed the subject draft report prepared for the National Shipbuilding Research Program by Peterson Builders, Inc.

2. The majority of the report deals with specific safety problems with which the Safety Action Team dealt. The specific issues in the report are factually not necessarily identical to issues of importance at this activity and therefore I address my comments to the project rather than to the specific problems addressed or solutions developed by Peterson.

3. The report outlines a successful effort to utilize quality circle techniques to solve safety problems. I believe that it is axiomatic that such an approach to safety will work at any activity which is both dedicated to a participative management system and to improving safety in the work place.

4. In order for such a program to be effective at NNSY it should be implemented at the shop level or lower. More involvement of labor should occur. Peterson's Safety Action Team probably gained more management acceptance of its ideas due to the relatively high position of its members, but I believe that employee participation should be maximized. I do feel, however, that it is important to involve both supervisors and labor on such a team.

5. The program at Peterson also achieved its success in large measure because, (1) the team included members who possessed the technical expertise to develop sound engineering solutions to problems, (2) management provided strong positive feedback to the team (it implemented most proposals), and (3) each proposal included accountability for implementing the proposal. In short, the program will work anywhere that management is committed to making it work.

6. The conclusion section of the report could have been better prepared. The statistical information presented should have been presented as a rate rather than in pure numbers. It then would give an indication of the effect workload fluctuations, which is disclaimed in the report (see page 44).

7. In conclusion, I would strongly encourage such a program at this activity and would be happy to work with code 102 to implement such a program.

PAPER NO. 2 SUBMITTED BY GREGORY L. SCHWEI, INTERNATIONAL FEDERATION OF PROFESSIONAL/TECHNICAL ENGINEERS, LOCAL 25, VALLEJO, CA

It is relief to indicate there is an oasis of pro-active management experience on the plain of shipyard management. It is with satisfaction this discusser affords feedback on the Peterson Builders experience. Peterson Builders is to be commended for their ability to synthesize employee-involvement from their quality circles experience to safety action teams. All too oft the experience is management does not approve of the cook-book recipe (read consultant) result, and hurls the baby out with the wash. The aptitude to modify the recipe, and save the baby, is uncommon among shipyard managers.

Uncommon aptitude is not required to glean the applications of Peterson Builders, and these applications decidedly outweigh the fluff in the paper. The blemish of Peterson Builders is the pervasive paternalistic attitude of management. This paternalism may survive in the peninsula of Wisconsin; however, it is doubtful to survive in a cooperative attitude between Union and management.

This paternalism is disclosed in the second project of the group. ". . . the group determined that(sic) there were seven issues that would have to be resolved in order(sic) for an overall plan to work. . . 7) Input from production supervision to incorporate their opinions/needs. " It is obvious paternal management does not need input from production workers, for management knows best. A side reaction of paternalism is sexism—a social disease ("Each supervisor is responsible for his men . . . .").

Another example of paternalism is given in passing-the-word-only to supervisors-on implementation of the cable-hanging system. ''. . . supervisory people were in attendance. . . . The session was video-taped so that(sic) any new supervisors who would need to be brought upto speed could receive an overview at their convenience. ” The inquiry of how difficult would it be to show the video to workers begs requesting by this discussor. Perhamanagement knows best, for production workers might not be able to comprehend the wizardry of this new technology.

Project one of the team reduced production worker injuries. The initial thrust was to reduce eye, hand, and back injuries. Peterson Builders relates a reduction in eye injuries. The obvious inquiry is was there a reduction in hand and back injuries. Other inquiries remain on how was the injury reduction accomplished by management. Was the reduction due to further supervisory awakening. Was the reduction due to a less than satisfactory supervisory evaluation affecting the pocket-book ($). What were the evaluation forms. Was there an actual change due to the evaluation form. Did any supervisor get rated less than satisfactory on the evaluation. What happened to supervisors rated better than satisfactory at Peterson Builders.

Project three and four are the cream of Petersons Builders. The how-to and particulars afforded in these projects should make application adaptable to any yard. In the value judgement of this discusser, the adaptability of project three and four demonstrates the taxpayer investment in this contract at Peterson Builders.

The conclusion of the Peterson Builders experience is Union/management cooperation does not live by quality circles alone. Quality circles are a management tool, and rank neither Unions nor labor on parity with management. This perception is not denied by the workforce in the pomp/circumstance of management “commitment.” Peterson Builders has participated in this management fad. The flow and ebb of quality circles has occurred at Peterson Builders (At its peak, (sic) 18 circles were active. . ..). It is the want of this discusser the aptitude to save the baby will endure, and other employee-involved problem-solving groups will bloom at Peterson Builders. It is a later want of this discusser pro-active management become the norm v the exception on the plain of shipyard management.

LABOR VIA UNUM SOLIDUM ONMIUM VINCIT

PAPER NO. 3 SUBMITTED BY WILLIAM BURNS, PRESIDENT PLANNERS-ESTIMATORS, PROGRESSMEN & SCHEDULERS ASSOCIATION LOCAL NO. 5

Safety is one of the biggest problems a shipyard will have in its everyday business. The development and implementation of a SAFETY ACTION TEAM is a critical part of operating a safe shipyard.

With the use of Quality Circles concept and the idea that the S.A.T. should “REPRESENT A BROAD SECTION OF THE YARD”, PETERSON BUILDERS have developed a "SAFETY TEAM” that has cut their accident rate considerably.

The SAFETY ACTION TEAMS first problem (wearing of safety equipment) was an ice-breaker. It not only started the S.A.T. out on a good foot it made the whole shipyard aware of safety and that the S.A.T. is serious about the safety of EVERYONE on the shipyard.

PETERSON BUILDERS should be commended for their foresight and ability to involve their employees. You can not emphasize how important it is to “GET & KEEP” employees involved in your everyday decision making.

PETERSON BUILDERS have shown they are serious about involving their employees and that “LIFESAVERS” are everywhere.

Respectfully